SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MARCH, 1930.

GENERAL PHYSICS.

853. The Millilitre. V. Stott. *Nature*, 124. *pp.* 622–623, *Oct.* 19, 1929.

Discusses the two types of volume unit, typified by the cm.^{3} and the litre respectively. The former is defined by reference to a length measurement, and the latter by reference to a mass; in fact, a litre is the volume occupied by the mass of 1 kg. of pure water at its maximum density and under normal atmospheric pressure. The historical evolution of the units is explained and their present status pointed out. The experimental relation between them is quoted, *viz.*, 1 litre = $1000{\cdot}02_8$ cm.^{3} It is pointed out that care must be exercised in using glassware calibrated in c.c., since this term is sometimes used for yet a third unit. Of two flasks marked 1000 c.c., one might contain 1000 cm.^{3} and the other 1001·98 cm.^{3}

J. H. A.

854. Molecular Air Pumps. E. N. da C. Andrade. *Nature*, 124. *pp.* 657–659, *Oct.* 26, 1929.

An elementary account of the principles underlying molecular pumps for high vacua, both of the mechanical (*e.g.*, Gaede and Holweck) types and of the diffusion type with or without condensation, as exemplified respectively by the Gaede and the Langmuir mercury pumps. *n*-Butyl phthalate is mentioned as an alternative to mercury in the latter type of pump.

L. V. C.

855. Flowmeter for Gases. W. Gerlach and H. Mayer. *Zeits. f. techn. Physik*, 10. 10. *pp.* 457–458, 1929.

Static manometers are unsuitable for measuring the speeds of modern pumps of the diffusion type. In the apparatus described—due in principle to Heis [see Abstract 2882 (1924)]—the pump main is shunted by two tubes in series, directed respectively upon the two halves of a delicately suspended mirror or vane. At great sensitivities and very low pressures, the Brownian movement causes irregularities in the deflection of the vane, but at pressures of about 10^{-4} mm. a flow of 10^{10} molecules per sec. may be observed with certainty. The deflection may be followed by using either a mirror or a pointer attached to the suspension. For rapid speeds of pumping a measurable deflection is obtained even when the main is unobstructed; at lower speeds, the main may be temporarily closed by a large-bore tap. Brief reference is made to applications of the apparatus, *e.g.*, to the slow drying of solids.

L. V. C.

856. Registration of Pendulum Oscillations without Material Connections. G. Ferrié. *Roy. Astron. Soc., M.N.* 89. *pp.* 713–718, *Oct.*, 1929. *Supplement. In French.*

This problem is important when studying certain astronomical and geophysical questions. The author points out the difficulties contingent on the irregularities in shape and position of the ratchet teeth; the difference in lengths of consecutive seconds may amount to the hundredth of a second, and it is impossible to use even the slenderest material connection without influencing the functioning of pendulums in (say) the determination of the constant of gravitation, so that its mean value only can be found, though it may be subject to periodic variations from tides in the terrestrial crust, etc. He refers to the properties of lamps with three electrodes [see Abstracts 1537 and 1538 (1925) and 425 (1926)], and describes a procedure which needs nothing but the employment of triodes, without the use of photoelectric cells. The principle of this method is the production of high-frequency oscillations in any apparatus using triode lamps; the current plate of the lamps has values notably different according as the system is, or is not, in a state of oscillation. A diagram and a detailed description of the apparatus are given. A. S. D. M.

857. Interfacial Tensions of the Systems Water—*n*-Butyl Alcohol, Water—*i*-Butyl Alcohol, Glycerol—*i*-Butyl Alcohol. K. Silbereisen. *Zeits. f. phys. Chem.* 143. *Abt. A.* 2. *pp.* 157–166, *Sept.*, 1929.

Interfacial tensions were determined by the capillary-rise method, the capillary being placed along the axis of a long vertical tube, water-jacketed externally and thermostatically controlled. The values found for σ in the three systems named were respectively: 1·60 to 1·56 dynes/cm. from 4° to 37° C.; 1·61 to 1·81 between 3° and 37° C., with a maximum of 1·86 at 27° C.; 0·76 to 0·038 between 1° and 19° C. Such systems of low interfacial tension are extremely useful in determining the pore-size of filters and ultra-filters by Jaeger's method, and are superior to systems employing salt solutions in that they are less sensitive to temperature changes. L. V. C.

858. Interpretation of the Temperature Coefficient of Surface Tension. N. K. Adam. *Phil. Mag.* 8. *pp.* 539–547, *Oct.*, 1929.

The Eötvös "constant," $k = -d/dT[\gamma(Mv)^{2/3}]$, is an unreliable indication of association in polar liquids since it is affected by molecular orientation, thickness of surface layer, etc. The author evaluates the temperature coefficient, $-d\gamma/dT$, in terms of the lateral bombardment pressure F of molecules in the surface layer, and shows that $dF/dT(= -d\gamma/dT)$ decreases to a steady value, independent of the length of the molecular chain, as the number of atoms in the molecule increases. Experimental values of $-d\gamma/dT$ obtained by the author and by Hunten and Maass [see Abstract 1402 (1929)] show that for single chain polar compounds (*e.g.*, fatty acids, amines, etc.) this limit is reached with a chain about 10 atoms long, while the paraffins (non-polar) probably require twice this number. Triple-chain polar compounds (*e.g.*, triglycerides) reach a lower limiting $-d\gamma/dT$ with a chain-length of about 10 atoms, indicating that the three chains, though united at one end, are capable to some extent of independent thermal vibration. L. V. C.

859. Calculation of Surface Tension from the Weights of Drops. T. Iredale. *Zeits. f. phys. Chem.* 144. *Abt. A.* 1–2. *pp.* 158–159, *Oct.*, 1929.

Critical comments on the paper of Palitzsch [see Abstract 1401 (1929)] with references to the priority of Harkins and Iredale, to Tate's equation and Goard and Rideal and to Lohnstein. H. B.

860. Theory of Glass Blowing and Drawing. H. Schlechtweg. *Ann. d. Physik*, 2. 7. *pp.* 805–846, *Sept.* 4, 1929.

Mathematical. The equations of motion of a viscous fluid when the viscosity is a function of position are investigated, and some particular solutions for tubes and thin spheres are obtained. W. G. B.

861. Viscosity Measurements by the Capillary Flow Method. S. Erk. *Zeits. f. techn. Physik*, 10. 10. *pp.* 452–457, 1929.

The corrected Poiseuille equation may be put into the form (for liquids): $\eta = (\pi r^4 t/8lV)(p_1 - p_2) - m\rho V/8\pi lt$, where m is a constant. By considerations of the static and dynamic pressures in the liquid during its entry into and passage through the capillary, the author finds that $m > 1$, selecting the value $m = 1 \cdot 1$ as most probable. The correction factor is determined in part by the exaggerated drop in static pressure occurring at the inlet end of the tube; neglecting this, $m = 1 \cdot 0$. A similar correction is necessary in the case of gases, in addition to that resulting from the acceleration of the gas as it expands in passing through the tube. The calculated factor in this case agrees with the mean value (1·39) determined experimentally by Trautz and Weizel for air, hydrogen and CO_2 [see Abstract 440 (1926)]. L. V. C.

862. Physical Properties and Constitution of Mineral Lubricating Oils. S. Kyropoulos. *Zeits. f. phys. Chem.* 144. *Abt. A.* 1–2. *pp.* 22–48, *Oct.*, 1929.

A method is given for determining to which particular group of substances a given organic compound belongs, with particular application to mineral lubricating oils. By this method Pennsylvanian lubricating oils, as well as numerous other hydrocarbons so far of unknown constitution, have been identified as isoparaffin mixtures. The method adopted is based on diagrams showing the relationship between molecular weights and refractive indices for homologous series of the paraffins. Other physical constants as, for example, viscosity, are also employed in this connection. J. K.

863. Relation between Physical Characteristics and Lubricating Values of Petroleum Oils. E. D. Ries. *Indust. and Engin. Chem.* (*Analytical Edition*), 1. *pp.* 187–191, *Oct.* 15, 1929.

A general paper wherein tests for physical characteristics are discussed with reference to lubrication. It is shown that whereas some tests are satisfactory, others are non-essential, still others inadequate and need to be changed and, moreover, certain new tests have still to be devised. It is shown that paraffin wax decreases Conradson carbon values and that temperature coefficient of viscosity changes by vacuum distillation. According to the author the tests to be abandoned are gravity, colour, flash and fire; those to be retained, carbon-residue, viscosity and viscosity-temperature coefficient; and those to be changed or planned afresh, cold test, evaporation, "oiliness" and resistance to oxidation. J. K.

864. Friction, Heat Conductivity and Diffusion in Gaseous Mixtures. M. Trautz and W. Ludewigs. *Ann. d. Physik*, 3. 3. *pp.* 409–428, *Oct.* 30, 1929.

The present work is a record of an experimental determination of the coefficient of friction in pure gases by direct measurement and from this of a determination of the friction coefficients for their mixtures. The apparatus used is similar to that employed in a previous paper [see Abstract 440 (1926)]. The results for air, hydrogen, carbon monoxide, argon, hydrogen/carbon monoxide mixture, hydrogen/argon mixture, hydrogen/$Fe(CO)_5$ mixture, $CO/Fe(CO)_5$ mixture, are given in a series of tables and are found to be in good agreement with other authors. In the case of hydrogen and air, the friction coefficients are measured at temperatures of 20°, 100°, 200° and 250° C. The value of q is calculated from the curves. In the mixtures of hydrogen and CO with iron penta-carbonyl vapour, the coefficient of friction up to a carbonyl content of 2½ % was measured. From the curves so obtained the value for the friction coefficient for carbonyl is deduced as being approximately $\eta = 882 \cdot 0 \times 10^{-7} \pm 10\%$, by extrapolation. From the results obtained a method is devised whereby at low percentage mixtures of high molecular vapours with gases, the coefficient of friction and the heat conductivity of the pure vapour can be estimated. The conductivity of carbonyl vapour is therefore given by $\lambda = 3 \cdot 1 \times 10^{-5}$. Tables are also appended for the isothermal diagrams of the various mixtures. S. G. B.

865. New Hydrodynamical Theory. G. Mazzone-Sangiorgi. *Accad. Lincei, Atti*, 9. *pp.* 1085–1090, *June* 16, 1929.

Develops a new theory of hydrodynamics sketched in two separate publications and based upon three theorems concerning the rotation of a fluid element, the resistance encountered by it and the horizontal reaction at the basis of the element. E. E. F. d'A.

866. Fredholm's Integral Equations for the Hydrodynamics of Viscous Fluids. Part I. H. Faxén. *Arkiv f. Mat. Astron. och Fysik, Stockholm*, 21. A. 14. [40 *pp.*], 1929. *In German.*

The author attempts to calculate the resultant force and the resultant moment of the forces which act upon a surface when the velocity components have given values and disappear at infinity. Assuming the boundary conditions for vanishing viscosity μ, Oseen has derived a solution for the case of the uniform translatory motion of a rigid body. Under the additional assumptions that a solution does exist and should possess certain derivatives, the author has now shown the sufficiency of the Oseen hypothesis for the case where the body possesses a continuously varying tangential plane. The paper is entirely mathematical. H. H. Ho.

867. Systems of Double Rows of Line Vortices in a Channel of Finite Breadth where the Axis of the Row is Parallel to the Axis of the Channel. L. Rosenhead. *Cambridge Phil. Soc., Proc.* 25. *pp.* 277–281, *July*, 1929.

The paper investigates the possibility of the existence of a double row of vortices with the axis parallel to the axis of the channel. It is shown that if the system is to move forward as a whole, then the only possible types of double row are the symmetrical and the unsymmetrical forms, with the centre line of the system coincident with that of the channel. Consequently, if a body moves parallel to the channel walls, but not in the centre line, then the steady part of the vortex system will arrange itself so that its axis coincides with that of the channel. J. H. A.

868. Fundamental Problem of Vortex Theory. J. Pérès. *Comptes Rendus*, 189. *pp.* 680–682, *Oct.* 28, 1929.

Difficulties in the treatment of the vortex theory in recent papers by

Villat [see Abstract 2343 (1929)] and by Delsarte [see Abstract 3455 (1929)] due to the occurrence of terms in r^{-2} in the integral expressions derived are removed by using the boundary condition in such a manner that terms in r^{-1} only occur in the expressions. J. S. G. T.

869. Calibration of an Orifice. H. W. Swift. *Phil. Mag.* 8. *pp.* 409–435, *Oct.*, 1929.

In previous papers the author investigated certain of the more important factors which produce systematic changes in the coefficient of discharge from an orifice [see Abstract 1132 (1928)]. In the present paper certain other factors which determine the coefficient of discharge are considered, the theories put forward are applied in an examination of the discrepancies in earlier published results, and methods for the calibration of an orifice are suggested and described which may ensure a satisfactory registration under the various conditions of service. The form of orifice is dealt with as regards its shape and the effect of rounding, and also the geometry of approach. Calibration is considered in relation to limpid liquids, viscous liquids and gases and vapours. J. J. S.

870. Measurement of Stream Velocity by Air Bubbles. O. Miyagi. *Tôhoku Univ., Technol. Reports*, 8. 4. *pp.* 117–130, 1929. *In English.*

An experimental method of determining the sizes of bubbles is given [see Abstract 217 (1926)] and empirical formulæ deduced for measuring the mean stream velocity by the utilisation of bubble-size. H. H. Ho.

871. Plane Irrotational Motion of an Incompressible Liquid. A. Argand. *Comptes Rendus*, 189. *pp.* 568–570, *Oct.* 14, 1929.

Taking as variables the lengths of arcs of an element of liquid and of its orthogonal curve considered as positive in the direction of flow and of the principal normal, expressions are derived which afford elegant demonstrations of the diverse properties of the flow, *e.g.*, the assemblage of iso-speed and iso-inclination curves form an isothermal (or isometric) lattice. H. H. Ho.

872. Forced Surface Waves on Water. T. H. Havelock. *Phil. Mag.* 8. *pp.* 569–576, *Oct.*, 1929.

Some elementary cases of the waves on water due to the forcing produced by the horizontal oscillations of a vertical plane or cylinder are solved. The result is a travelling wave, together with a local disturbance. W. G. B.

873. Determination of a Surface from Given Data. D. Riabouchinsky. *Comptes Rendus*, 189. *pp.* 629–632, *Oct.* 21, 1929.

If there be a region limited interiorly by a surface Σ, formed by one or several distinct closed surfaces, and ϕ be a harmonic function which is regular to infinity and M a point of Σ, then a certain law of reciprocity appears to exist between the four functions which determine Σ, ϕ, ϕ_M, $d\phi/dn_m = q$, taken two by two. The six classes of problem which arise are now considered and their relationship with cavitation and turbulence discussed. H. H. Ho.

874. Diffusion of Non-Spherical Particles. R. Gans. *Ann. d. Physik*, 3. 3. *pp.* 429–432, *Oct.* 30, 1929.

A correction to a former paper on the subject [see Abstract 1019 1929)]. Instead of p the factor $\sqrt{p}$ should appear in equation (7). It is shown that it is not possible to determine the dimensions and form of the suspended particles by means of diffusion measurements. H. N. A.

875. Stress Produced in a Semi-Infinite Solid by Pressure on Part of the Boundary. A. E. H. Love. *Roy. Soc., Phil. Trans.* 228. *pp.* 377–420, *Oct.* 19, 1929.

The potential method, applied originally to this problem by Boussinesq, is carried to a further stage in order to determine the displacement and stress in a semi-infinite homogeneous and isotropic solid having an infinite plane boundary, due to pressure on part of the boundary. The method is applied to special problems of rectangular and circular areas under uniform pressure. Difficulties in regard to finiteness and determinacy of stress are evaded by assuming that the applied pressure is not strictly uniform. A numerical discussion provides material for forming an estimate of strength. J. S. G. T.

876. Elasticity of Steel and Elinvar. A. Jaquerod and H. Mügeli. *Helv. Phys. Acta,* 2. 6. *pp.* 419–444, 1929.

The system described consists of attaching a spring made of the metal to be examined to a torsion balance of known periodicity and subsequently determining the new periodicities at different temperatures between 15° C. and 150° C. The amplitudes varied from 3° to a few minutes of arc. The apparatus and the methods adopted are described in some detail, together with the necessary mathematical treatment of the results required to arrive at the values of the thermoelastic coefficients. The results (of which representative examples are tabulated) confirm those of previous investigations [see Abstract 1020 (1929)]. It is noted that the value of the coefficient does not become stable until some time has elapsed and until after a number of swings. J. G. H. B.

877. General Formulation of Cauchy's Integral and the Equations of Plane Elasticity. N. Théodoresco. *Comptes Rendus,* 189. *pp.* 565–567, *Oct.* 14, 1929.

Pompeiu's formula, which includes Cauchy's integral as a particular case, *viz.*,

$$f(z) = \frac{1}{2i\pi}\int_C \frac{f(u)}{u - z}\,du - \frac{1}{\pi}\int\!\!\int_D \frac{f_1(\nu)}{\nu - z}\,dw,$$

where $f(z)$ is a function of a complex variable defined at the interior of a simple closed contour C, u is a point which describes the contour, ν a point which moves throughout the interior of the region D, dw an element of area in D, and $f_1(z)$ the areal derivative of $f(z)$ within D, is utilised in the present paper for the integration of the equations of elastic equilibrium in the case of a plane figure. H. H. Ho.

878. Determination of Multiple Integrals and the Integration of Partial Differential Equations by a Planimeter. Dora Wehage. *Zeits. f. Instrumentenk.* 49. *pp.* 425–444, *Sept., and pp.* 477–496, *Oct.,* 1929.

The linear and integrating planimeters are not considered, but only the ordinary polar planimeter. The principle of its practical use is first explained. The use of the principle in the determination of multiple integrals is examined for: (1) angular moments, (2) polar moments of inertia for rotating bodies, (3) degrees of accuracy, (4) mean geometrical distances, and (5) radiation of heat from a square and from a cylindrical surface. The use of the planimeter for the integration of partial differential equations is considered for (1) the asymptotes of a pseudosphere, and (2) the telegraphic equations with given initial and boundary conditions. R. S. R.

879. Mechanical Means for the Production of Parabolæ, Hyperbolæ and Trajectories. J. Fritzen. *Zeits. f. Instrumentenk.* 49. *pp.* 457–464, *Sept., and pp.* 507–512, *Oct.*, 1929.

Particulars are given of forms of apparatus and their method of use in constructing parabolæ, hyperbolæ and trajectories. R. S. R.

880. Theorem of Maximum Kinetic-Dynamic Effect. E. Gugino. *Accad. Lincei, Atti*, 9. *pp.* 1090–1095, *June* 16, 1929.

Further work on a principle treated in a preceding paper [see Abstract 3465 (1929)] showing how a principle announced by Hertz can be deduced which constitutes a geometrical interpretation of the principle of minimum construction enunciated by Gauss. E. E. F. d'A.

881. Criteria for Stability of Small Motions. R. A. Frazer and W. J. Duncan. *Roy. Soc., Proc.* 124. *pp.* 642–654, *July* 1, 1929.

When a dynamical system of m degrees of freedom receives a small disturbance, the m linear differential equations resulting from the application of Lagrange's equations have solutions $X_1e^{\lambda t}$, $X_2e^{\lambda t}$, etc., where λ is a root of the equation

$$\begin{vmatrix} a_{11}(\lambda), & a_{12}(\lambda) \ldots\ldots\ldots\ldots & a_{1m}(\lambda) \\ a_{21}(\lambda), & a_{22}(\lambda) \ldots\ldots\ldots\ldots & a_{2m}(\lambda) \\ \vdots & & \vdots \\ a_{m1}(\lambda) & \ldots\ldots\ldots\ldots\ldots & a_{mn}(\lambda) \end{vmatrix} = 0,$$

which may also be written $p_0\lambda^n + p_1\lambda^{n-1} + \ldots + p_n = 0$. The stability of the system depends on the nature of the roots of this equation. It is shown that the necessary and sufficient conditions for complete stability are that p_0 and p_n, together with the $(n-1)$ determinants (T_r) of the following type, shall all be positive:

$$T_1 = p_1 \qquad T_2 = \begin{vmatrix} p_1 & p_0 \\ p_3 & p_2 \end{vmatrix} \qquad T_3 = \begin{vmatrix} p_1 & p_0 & 0 \\ p_3 & p_2 & p_1 \\ p_5 & p_4 & p_3 \end{vmatrix} \qquad T_4 = \begin{vmatrix} p_1 & p_0 & 0 & 0 \\ p_3 & p_2 & p_1 & p_0 \\ p_5 & p_4 & p_3 & p_2 \\ p_7 & p_6 & p_5 & p_4 \end{vmatrix}$$

The paper also treats the case where some or all of the parameters of the system are continuous functions of one or more variables; in this case, by alteration of the independent variable, a system may be changed from stability to instability, and the value at which this occurs is of great importance. It is shown that the critical point occurs either when $p_n = 0$ or $T_n - 1 = 0$, according to the type of instability which supervenes. J. H. A.

882. Poincaré Cycles and Theory of Auto-Permanent Oscillations. A. Andronow. *Comptes Rendus*, 189. *pp.* 559–561, *Oct.* 14, 1929.

These oscillations are expressed by differential equations which differ from those of mathematical physics and classical mechanics, since the systems which produce these phenomena are not conservative and maintain their oscillations by taking energy from non-periodic sources. Consideration of a simple case analogous to a system with one degree of freedom affords equations which corresponds mathematically to the stable Poincaré cycles. H. H. Ho.

883. Almost Periodic Functions and Vibrating Systems. C. F. Muckenhoupt. *J. Math. Phys., Mass. Inst. of Technology,* 8. *pp.* 163–199, *Oct.*, 1929.

This paper treats finite vibrating systems of an infinite number of degrees of freedom through the medium of almost periodicity, and so attempts to bring out the advantages and difficulties of the method, to systematise and generalise the attack, and to classify fields where such procedure is fruitful. Only such systems as are representable by linear differential equations are used, and the subject matter is treated in four chapters. Theory of functions almost periodic in the mean; proof of the almost periodicity in the mean of a loaded vibrating string; existence of the solution of the problem; the completion of the problem, and the closure of the eigen functions or characteristic functions. A biographical Appendix completes the paper. H. H. Ho.

884. Crystalline Structure of Bromides of Bivalent Metals. A. Ferrari and F. Giorgi. *Accad. Lincei, Atti,* 9. *pp.* 1134–1140, *June* 16, 1929.

Cobalt, ferrous, magnesium and manganese bromides have crystal structures of the cadmium iodide type, the characteristic constants being as follows; $CoBr_2$, $a = 3\cdot685 \pm 0\cdot005$ Å., $c = 6\cdot120$ Å., $c:a = 1\cdot66$, density $= 5\cdot072$; $FeBr_2$, $a = 3\cdot740 \pm 0\cdot005$ Å., $c = 6\cdot171$ Å., $c:a = 1\cdot65$, density $= 4\cdot790$; $MgBr_2$, $a = 3\cdot815 \pm 0\cdot005$ Å., $c = 6\cdot256$ Å, $c:a = 1\cdot64$, density $= 3\cdot876$; $MnBr_2$, $a = 3\cdot820 \pm 0\cdot001$ Å., $c = 6\cdot188$ Å., $c:a = 1\cdot62$, density $= 4\cdot549$. Cadmium bromide, however, exhibits a rhombohedric cell of the magnesium chloride type with the dimensions, $a = 7\cdot72 \pm 0\cdot01$Å., $a = 61° 40'$; the cell contains four molecules, the calculated density being $5\cdot36$. T. H. P.

885. Internal Strain of Uniformly Distorted Aluminium Crystals. K. Yamaguchi. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 200. *pp.* 151–169, *Aug.* 23, 1929. *In English.*

Various specimens of aluminium crystals were uniformly distorted by subjection to various stresses (maximum tensile stress, $8\cdot21$ kg./mm.^{2}; shear stress, $3\cdot57$ kg./mm.^{2}). Numerous Laue and diffraction spectra photographs (many reproduced) were taken. It is concluded that: (i) the internal strain is measured by the curvature of the crystal, the radius of curvature being normal to the direction of slip; (ii) the amount of rotation increases almost linearly with the shear; (iii) a crystal showing greater resistance to slipping is more strained for a given shear, which shows that internal strain is closely related to degree of work-hardening; (iv) it seems probable that provided the strain due to slip does not exceed $0\cdot2$ to $0\cdot3$, the internal strain is chiefly due to the elastic curvature of the crystal produced by the slipping of a limited area on the slip plane. [See also next Abstract.] C. A. S.

886. Slip-Bands of Compressed Aluminium Crystals. K. Yamaguchi. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 205. *pp.* 223–241, *Sept.* 8, 1929.

An experimental study of the relation between the number of slip planes and the resistance of single crystals of aluminium to slipping during compressive distortion. A tentative theory of work-hardening of metals is offered. [See also previous Abstract.] W. H. Ge.

887. Arrangement of Micro-Crystals in Compressed Single-Crystal Plates of Aluminium. Y. Fukami. *Kyoto Coll. Sci., Mem.* 12. *pp.* 261–264, *Sept.*, 1929. *In English.*

The scattering of the orientations of the micro-crystals of aluminium in compressed single-crystal plates of aluminium was investigated. The orientations of the cubic micro-crystals of aluminium were found to be scattered by compression to some extent around the [110] axis which made the smallest inclination against the surface of the aluminium plate. It was also found that the amount of such scattering around the axis [110] increased with the reduction in thickness of the plate by compression, so that the arrangement of the micro-crystals tended to a fibrous one. The maximum angle of rotation of the micro-crystals of scattered orientations was seen to increase proportionally with the thickness of the plates by compression. AUTHOR.

888. Equidistant Slip Planes in Plastic Deformation of Metallic Single Crystals. L. Tronstad. *Zeits. f. techn. Physik*, 10. 10. *pp.* 445–452, 1929.

In the tensile deformation of metallic single crystals, especially of tin and bismuth, it is often observed that the slip bands, visible as ellipses on the surface of the specimen, occur in positions equidistant from each other along the specimen. It is shown that this systematic arrangement of the planes of slip is due to stationary sound waves set up in the crystal. The effect of these waves on the stress distribution in a single crystal wire is considered. Additional stresses can be set up by the waves, especially in the region of nodes, these stresses being dependent on the mutual displacements of the vibrating particles. In the extension of the specimen the conditions are such that resonance can cause intense local increase in the amplitude of a particular overtone of the wire. The forces introduced by the resonance wave in the vicinity of the nodes may be sufficiently great to cause slip in these positions, even when the simple loading stress alone is much too small to overcome the lattice forces. The theory also provides an explanation of the " premature yielding " of metals under stresses far lower than the theoretical minimum yield stress. A. J. M.

889. Production of Large Single Crystals of Zinc. M. Ichihara. *Tôhoku Univ., Technol. Reports*, 8. 4. *pp.* 1–8, 1929. *In English.*

A peculiar feature in obtaining large single crystals of zinc by the strain method is the limiting strain. This should be as severe as possible. The straining method, annealing temperature and its duration are described. AUTHOR.

890. Twinning Plane in Crystals of Zinc. M. Ichihara. *Tôhoku Univ., Technol. Reports*, 8. 4. *pp.* 9–19, 1929. *In English.*

The writer first determined experimentally the twinning plane of zinc crystals as $(10\bar{1}2)$ by observing the twin lamellæ on the basal, prismatic, and diagonal planes. Next, for the purpose of testing the twinning rule, the writer graphically calculated the directions of the secondary twin lamellæ which must occur in the primary twin lamellæ on each plane, based upon the rule that the twin occurs along the twinning plane $(10\bar{1}2)$. The results calculated graphically were identical with observed values of secondary twins. [See also preceding Abstract.] AUTHOR.

891. Method of Determining the Direction of the Axis of a Fibrous Arrangement of Micro-Crystals. S. Takeyama. *Kyoto Coll. Sci., Mem.* 12. *pp.* 257–260, *Sept.*, 1929. *In English.*

A method is described of determining the direction of the axis of a fibrous arrangement of micro-crystals by treating the Laue photograph of the specimen with the "crystallographic globe." AUTHOR.

892. Term Separation in Crystals. H. Bethe. *Ann. d. Physik*, 3. 2. *pp.* 133–208, *Oct.* 8, 1929.

The influence of an electric field of given symmetry (crystal field) upon an atom is treated from the standpoint of wave mechanics. The atomic terms separate in a manner which depends on the symmetry of the field and the rotation impulse of the atom. *s*-terms separate generally, but *p*-terms not in fields of cubic symmetry. For the case where the single electrons of the atom must be treated separately (reciprocal effect in atoms), the special functions of zero approximation are applied to every term in the crystal, from which a characteristic grouping of the electron density follows according to the axes of symmetry of the crystal. The magnitude of the term separation alters in the order of some hundred cm^{-1}. In the case of tetragonal symmetry, a quantitative measure for the deviation from cubic symmetry can be defined, which determines uniquely the most stable electronic arrangement in the crystal. H. H. Ho.

893. Crystal Structure of Solid Nitrogen. L. Vegard. *Zeits. f. Physik*, 58. 7–8. *pp.* 497–510, 1929.

In a specially designed X-ray spectrometer it has been possible to solidify nitrogen to obtain the form stable at temperatures below 35·5° K. and to take powder photographs of the specimens. The unit cell is cubic with an edge $a = 5 \cdot 66$ Å., and the lattice, which is decidedly molecular, belongs to the space-group T^4. The interatomic size of 1·068 Å. agrees well with that of 1·10 Å. for the gaseous molecule. W. H. GE.

894. Method of Determining the Axial Ratios of a Crystal from X-Ray Diffraction Data. Axial Ratio and Lattice Constants of Zinc Oxide. M. L. Fuller. *Science*, 70. *pp.* 196–198, *Aug.* 23, 1929.

A very accurate method of finding the correct value for *a* in a cubic crystal has been developed by Davey, which consists of plotting on arithmetic probability paper the values of *a* calculated from the observed spacings against the percentage of the values that are equal to or smaller than their respective values. The method has here been adapted to determining the axial ratio in hexagonal crystals. The axial ratio is found from the Hull and Davey charts approximately, and a group of seven or eight values round about this is selected. The value of *a* is then calculated for each, and these values are plotted on probability paper according to Davey's method, one curve for each ratio. That curve which is nearest a straight line gives the true axial ratio. The method is illustrated for ZnO. J. E.

895. Structure of Naphthalene and Anthracene. J. M. Robertson. *Roy. Soc., Proc.* 125. *pp.* 542–569, *Oct.* 1, 1929.

The crystal structures of naphthalene and anthracene are examined in detail by the rotating crystal photographic method, and approximate estimates of intensities are made. The space group is C_{2h}^5 in each case, the unit cells containing two molecules, which, therefore, possess a centre of symmetry. The geometrical structure factor in its general form is developed for these conditions. A periodic structure parallel to the *c* axes of the crystals is deduced from the reflections, and the periodicity is estimated. The scattering centres lie nearer to the *ac* than the *bc* planes, but no simple structure with a plane of symmetry parallel to the *ac* plane is possible. If it is assumed that the scattering centres lie in two uniform rows parallel to the *c* axes, forming a chain-like structure, it is possible to develop a compact geometrical structure factor for the general case of *n* scattering centres. Comparison with simple models limits the range of parameters for general discussion. Detailed examination of the parameters indicates the values which give the best account of the intensity variations in the principal spectra of naphthalene and anthracene, independently of any model structure except for the assumption of the uniformity mentioned. The two structures are the same within the limits of experimental error. The dimensions and relations of the molecules of naphthalene and anthracene, calculated from the final values of the parameters, differ only slightly from Bragg's tetrahedral structure. The chain structure is very similar in many dimensions to that of $C_{29}H_{60}$, as determined by Müller [see Abstract 46 (1929)]. The tetrahedral properties of the carbon atom, therefore, appear to be maintained in these aromatic structures. A. J. M.

896. Interpretation of X-Ray Crystal Photographs. Part II. Complete Rotation Photographs. W. H. George. *Phil. Mag.* 8. *pp.* 442–456, *Oct.*, 1929.

The paper describes a simple mathematical instrument which directly interprets principal axis, complete rotation photographs of cubic, tetragonal, hexagonal and trigonal crystals. A rotating cursor is clamped upon one scale, at a graduation depending upon the size of the unit cell and the wave-length of the X-rays. The line of the cursor then intersects two other scales at a series of points, each part of which corresponds to the crystal indices and the row line reading upon the film where the spot of the photograph is to be sought. In combination with the grid method [see Abstract 2079 (1929)] of measuring X-ray photographs, the method is entirely independent of the type and dimensions of the spectrometer, the wave-length of the X-rays, or the size of the unit cell of the particular substance, and it involves no graphical construction or calculation. Partial applications of the work are described, and some tables of constants are given for use in connection with reciprocal lattice methods for interpretation of rotation photographs. W. V. M.

897. Chemical and X-Ray Spectrographic Investigation of Silicates. The Hornblende Group. B. Gossner and F. Spielberger. *Zeits. f. Krist.* 72. 2. *pp.* 111–142, *Oct.*, 1929.

A continuation of earlier work on certain members of the hornblende group of silicates. The chemical composition, relevant space-lattice dimensions and specific gravity have been determined for further members of the group. The most important isomorphous substitutions and the classification of the several members within the group have been determined, while the probable space group type is deduced. The criteria of the different series of metasilicates are: (1) Monoclinic pyroxenes: diopside type, Si_2O_6MgCa; 4 units $Si_2O_6Me_2$ in the elementary cell. (2) Monoclinic amphiboles: tremolite type, $3SiO_3Mg \cdot SiO_3Ca$; 8 units $Si_2O_6Me_2$ in the elementary cell. (3) Rhombic enstatite group: simple Mg-metasilicate with 8 units $Si_2O_6Me_2$ in the elementary cell. These three groups are closely related in the dimensions of the elementary cell. (4) Ænigmatite: resembles hornblende in volume for the unit $Si_2O_6Me_2$, but differs in having a larger elementary cell with 7 units. (5) The wollastonite-rhodonite group: not only shows wide differences in the elementary cells, but also is not related to the other metasilicates in the volume for the unit $Si_2O_6Me_2$. A. J. M.

898. Order of Fractionation of Rare-Earth Bromates and Search for Illinium. J. K. Marsh. *Chem. Soc., J. pp.* 2387–2389, *Oct.*, 1929.

Gives results of work on the order of fractionation of bromates of the rare-earths at 15° to 10°, as Sm and Eu, Gd, Nd, Tb. The order of separation at temperatures falling nearly to 0° was found to be Sm and Eu, Gd, Nd, Tb, Pr, Dy, Ho, Yt, which shows certain inversions when compared with previous results obtained at 20°. A search for Il among the rare earths in Joachimstal pitchblende is described, but no indications of the bands ascribed to Il could be found in the chloride absorption spectra examined. C. O. B.

899. Effect of Boundary Distortion on the Surface Energy of a Crystal. Beryl M. Dent. *Phil. Mag.* 8. *pp.* 530–539, *Oct.*, 1929.

The surface energy of a crystal may be represented as the sum of two terms—a term corresponding to the mutual energy of the two parts of the crystal which are separated to form new surface and a term representing the change in energy of the crystal consequent upon the distortion of the structure at the surface. The former term is available immediately from the calculations of Lennard-Jones. The latter term is determined principally by the change in energy of the atoms in the top layer, as it has been shown [see Abstract 692 (1929)] that surface distortion is practically confined to this layer. The energy of an atom of the top layer before the formation of the surface is obtained by a fairly straightforward calculation from the known repulsive forces and the electrostatic forces between the ions. For the same atom in the surface, in addition to the above forces, which are modified, the polarisability of the ions has to be taken into account and represents a new contribution to the energy. The final result of the calculations is that for the alkali halides taking into account the distortion of the surface modifies the estimated surface energy by an amount varying from 10 % to 26 %, which is not negligible as previously assumed. The corrected surface energy value is less than the uncorrected value assuming no surface distortion. W. S. S.

900. Energy Changes by a Variation from the Crystallographic Group. H. M. Evjen. *Phys. Rev.* 34. *pp.* 1385–1390, *Nov.* 15, 1929.

Investigates the possibility of energy minima by a systematic departure from the perfectly symmetrical crystalline lattice. A geometrically simple variation is considered. The surface (100-plane) of a heteropolar crystal of the face-centred type is contracted uniformly in patches, and the interior planes are likewise contracted in patches by amounts decreasing linearly with the distance from the surface. In this way a "mosaic" structure of a type previously suggested in the literature [see Abstract 2671 (1929)] is obtained. A numerical calculation of the change in potential energy is carried out for rock-salt with certain simplifying assumptions. The change in energy is obtained as a power series in terms of the maximum displacement of the ions. Due to the slow convergence of this alternating series an approximate remainder term is introduced to take care of powers higher than the third. The series contains two parameters, namely, the linear extension of the patches and the depth of the cracks. The function, in general, is found to have two minima with respect to the displacement of the ions, one at zero displacement and a second at a finite displacement. The second minimum, depending on the parameters, may be negative with respect to the former. The function also has minima with respect to the two parameters, thus proving the static stability of a mosaic structure of definite dimensions. These considerations, with only minor changes, are also applicable to a mosaic structure in the interior of the crystal. AUTHOR.

901. Crystal Structure of Ice between 0° C. and − 183° C. W. H. Barnes. *Roy. Soc., Proc.* 125. *pp.* 670–693, *Nov.* 1, 1929.

An investigation of the structure of ice by means of X-rays and single crystals is described, and a brief survey of the literature is given. The types of apparatus and the crystals employed are indicated, and an interpretation of the Laue photographs, single-crystal rotation photographs about the principal crystallographic axes and oscillation photographs is given. The space group is found to be D_{6h}^{4} (dihexagonal bipyramidal) or D_{3h}^{4} (ditrigonal bipyramidal), with the probability in favour of the former. The dimensions of the unit cell are found to be $a_0 = 4\cdot53_5$ Å., $c_0 = 7\cdot41$ Å., $c : a = 1\cdot634$. The number of molecules per unit cell is four. The geometrical structure factor for two sets of possible equivalent points is given, and one set is shown to be incompatible with observed halvings. The equivalent points for the diffracting centres in the unit cell are found to be $\frac{1}{3}, \frac{2}{3}, \frac{1}{16}; \frac{1}{3}, \frac{2}{3}, \frac{7}{16}; \frac{2}{3}, \frac{1}{3}, \frac{9}{16}; \frac{2}{3}, \frac{1}{3} - \frac{1}{16}$. Intensity calculations for the proposed structure are shown to agree with visually estimated intensities. The placing of the hydrogen atoms is discussed, and arguments in favour of an ionic lattice are put forward. A complete structure for ice is proposed, and the accuracy of the cell dimensions is indicated. A series of powder photographs are shown to prove that no change in the structure of ice takes place between 0° C. and − 183° C. AUTHOR.

902. Intensively Dried Liquids. J. W. Smith. *Phil. Mag.* 8. *pp.* 380–383, *Sept.*, 1929.

Briefly discusses the latest results on intensively dried liquids, and examines earlier results using the new phenomena exhibited by these later ones. It is shown that certain of the new results possess disadvantages which do not allow of definite conclusions being drawn. Other phenomena, on the other hand, may be examples of the "slow" behaviour of dried liquids, some time being required for the inner equilibrium to be established after disturbance by temperature change. R. C. F.

903. Intermolecular Forces in Liquids. J. H. Hildebrand. *Phys. Rev.* 34. *pp.* 984–993, *Sept.* 15, 1929.

The volume energy of liquids E_v is formulated, as in the Born and Landé theory of the lattice energy of crystals, in terms of attractive and repulsive forces varying with inverse powers of the distance, or volume, giving $E_v = \frac{-a}{V^m}\left[1 - \frac{n}{m}\left(\frac{V_0}{V}\right)^{n-m}\right]$, where m and n are, respectively, the exponents of attraction and repulsion, a the attraction constant, and V the volume and V_0 the volume at absolute zero, or when the external pressure just balances the thermal pressure $T(\partial P/\partial T)_v$. The theory is tested by the use of the values of $(\partial E/\partial V)_T$ calculated by the aid of the thermodynamic equation of state from experimental values of $(\partial P/\partial T)_v$, also by the use of the energy of vaporisation. It is found: (1) that values of V_0 derived from highly compressed ether and mercury agree well with those derived from density at low temperatures; (2) that m varies from 1 for non-polar molecules, $m = 1$ corresponding to the attraction between quadripoles, to much less than 1 as polarity increases, $m = 1/3$ corresponding to dipole attraction; (3) that at ordinary temperatures and pressures the repulsive term is small for the liquids studied, except mercury, indicating a large value of n and that the attractive pressure is balanced by the thermal pressure; (4) that taking $a = 3180 \cdot 10^4$, $m = 1$, $n = 9$, and $V_0 = 79$, it is possible to calculate $(\partial E/\partial V)_T$ for ether from a molal volume of 79 c.c., in the liquid at 12,000 atmospheres, to a volume of 4000 c.c. in the vapour. It is suggested that the thermal pressure should be introduced into the calculation of lattice energies by the methods of Born and Landé and Pauling. AUTHOR.

904. Active Nitrogen. Z. Bay and W. Steiner. *Zeits. f. Elektrochem.* **35.** *pp.* **733–737**; *Disc.*, **737–738**, *Sept.*, **1929**. *Paper read before the Deut. Bunsen Gesell., Berlin, May*, **1929**.

By means of a spectroscopic method, suitable for the indication of unstable intermediate products in reacting and activated gases, arc lines of the nitrogen atom are obtained which prove the presence of atoms in active nitrogen. The atom concentration, as well as the intensity of the afterglow, are found to be directly proportional to the value of the capacity used for the condensed discharge for producing the active nitrogen. Active nitrogen, which is rich in atoms, has a very strong afterglow, whilst the weakening of the afterglow by a gentle discharge corresponds to a decrease in intensity of the arc lines. Considering the criterion given by Kaplan for the proof of metastable molecules, namely, the appearance of the four positive groups in the positive column of the aiding discharge, as permissible, then the metastable molecule concentration is a maximum if the producing discharge is uncondensed or only slightly condensed. The nitrogen thus obtained, of which the active product consists of metastable molecules, has hardly any visible afterglow. In the *Discussion*, **G. Schultze** queried the optimum value of water vapour used by the authors. In certain experiments carried out by von Wartenberg and himself, on active hydrogen, it would appear possible that a small increase in the added water vapour would lead to a definite higher gain; **B. Lewis** stated that the authors' results gave a reason for the results obtained by Kaplan and Cario in that the joining of a stream of stimulated molecules without afterglow with a stream of atoms which show afterglow would produce a strong afterglow at the junction. As a reply to G. Schultze, the authors stated that water vapour differed from hydrogen, and they found that any addition above their optimum value definitely extinguished the afterglow. R. C. F.

905. Molecular Condition of Fused Sulphur. B. Lange and W. Cousins. *Zeits. f. phys. Chem.* **143.** *Abt. A.* **2.** *pp.* **135–138**, *Sept.*, **1929**.

It is shown by an analysis of Tyndall light in fused sulphur that by increase of temperature the molecular complexity decreases. The equilibrium between dissolved and undissolved sulphur corresponds to the dissociation constant at the corresponding temperature, nevertheless it appears that the cooling process has a greater influence on the orientation and mass velocity of the molecules than has so far been appreciated. In fact, it is this observed influence which is used to explain the large variations heretofore obtained in connection with equilibrium determinations. J. K.

906. Molecular Structure of Triatomic Gases. P. N. Ghosh and P. C. Mahanti. *Phys. Zeits.* 30. *pp.* 531–537, *Sept.* 1, 1929.

Uses the extant measurements concerning the refraction and the dielectric constants of CO_2, SO_2, CS_2, and NO_2 to determine their frequencies and molecular models. CO_2 and CS_2 appear to have symmetrical linear models, SO_2 a triangular model, and NO_2 an asymmetrical linear model. E. E. F. d'A.

907. Existence of Stationary States. R. Peierls. *Zeits. f. Physik*, 58. 1–2. *pp.* 59–62, 1929.

The conditions for the existence of stationary states are defined for a special type of potential functions, such as occur in the problems of molecular structure. It is shown amongst other things that when there is a simple " dimple " in the potential curve stationary solutions always exist. This, however, is not necessarily the case if repulsive forces are active in the neighbourhood. H. N. A.

908. Limits of Applicability of the Cosine Law for Molecular Streams. H. Mayer. *Zeits. f. Physik*, 58. 5–6. *pp.* 373–385, 1929.

Uses the torsion balance method previously described [see Abstract 713 (1929)]. The cosine law for the distribution of the molecules in a stream through a small opening holds for openings of from 0·09 to 0·00006 mm.^{2} in a thin wall, even when the pressure in the space from which the molecules come is as high as 4·5 mm. Hg, provided that the pressure in the space into which they pass is kept low enough. If the wall is not thin enough, so that the hole forms a canal, the stream becomes concentrated towards the axis. The form of the stream is independent of the length of the canal when this is greater than three times the diameter, also of the diameter and of the nature of the gas. Evaluation of the experimentally determined impulse functions shows that the density of the molecules along the direction of the canal axis may be ten or twelve times as great as in the case of isotropic distribution of the emerging molecules. H. N. A.

909. Electron Impact Excitation in Mercury Vapour. W. H. Brattain. *Phys. Rev.* 34. *pp.* 474–485, *Aug.* 1, 1929.

The efficiency of excitation by electron impact of the 6·67-volt resonance level in the mercury atom has been studied as a function of the energy of the incident electrons. The electrons that have lost energy are separated out by a small retarding field and are measured. The number of collisions is calculated from the experimentally determined value of the mean free path. The range covered is 0·04 volt from 6·67 to 7·07, giving a value for every 0·1 volt of the interval. The efficiency reaches a maximum of about 0·06 at 6·77 volts and then falls off to 0·04 at 7·0 volts. The number of electrons scattered elastically at large angles by mercury vapour as a function of their energy was measured. The energy range covered was from 2 to 10 volts in steps of 0·2 volt.

E. E. F. d'A.

910. Collisions of the Second Order between Electrons and Excited Molecules. A. Leipunsky and E. Strauff. *Zeits. f. Physik*, 58. 1-2. *pp.* 104–128, 1929.

The existence of collisions between electrons and excited molecules (second order) in which energy is lost by the latter had been predicted by Klein and Rosseland, but had not been hitherto observed. The fact was used that in the oxidation of phosphorus many excited molecules are produced, and when electrons are passed through such a region some electrons are observed with velocities much greater than would be acquired under the existing potential difference. In a discussion of the experimental conditions it was shown that these electrons had obtained their additional velocities by collisions of this nature. A lower limit for the probability of these collisions was calculated to be 10^{-5}. From the mechanism for the possible neutralisation of these molecules the most likely value of this probability was found to be 10^{-3} to 10^{-4}, a value agreeing in order of magnitude with the probability of collision in the reverse direction. Some considerations on the significance of the observed phenomena for the mechanism of the propagation of explosive reactions are mentioned. R. S. R.

911. Proof of the Existence of Protons in Metals. A. Coehn. *Zeits. f. Elektrochem.* 35. *pp.* 676–680; *Disc.*, 680, *Sept.*, 1929. *Paper read before the Deut. Bunsen Gesell., Berlin, May*, 1929.

Studies the diffusion of hydrogen along a palladium wire from a region in the wire which is saturated with the gas. Finds that the amount of diffusion is influenced by a current in the wire, being greater in the direction of the current than in the opposite direction. This is explained by assuming that the hydrogen molecules are split up into protons and electrons, and that the protons are carried in the direction of the current by electrolytic action. The original paper should be consulted for the interesting details of the experimental method employed in the research. H. N. A.

912. Structure of the Proton and the Electron. R. Fürth. *Zeits. f. Physik*, 57. 7–8. *pp.* 429–446, 1929. *Phys. Zeits.* 30. *pp.* 895–898, *Dec.* 1, 1929.

The radii of the electron according to the classical theory and according to quantum mechanics combined with Heisenberg's principle of imperfect definition are contrasted. The principle is applied to light quanta, and the radii and impulses of electrons and protons are determined. The arguments are applied to the ratio of the proton to the electron and to the wave-length of cosmic rays. E. E. F. d'A.

913. Packing Effect in Atoms. S. Meyer. *Akad. Wiss. Wien, Ber.* 138. 2a. 5–6. *pp.* 431–438, 1929.

The packing effect of the protons is represented in a manner different from Aston's, hydrogen being taken as unity instead of oxygen. In this manner it is possible to arrive at an interpretation of the packing effects of the lighter atoms without a splitting of the curve into two branches. Periodicities are found which show a relation with the well-known periods in the so-called natural system of the elements. E. E. F. d'A.

914. Three-Dimensional Model of Atomic Energy Levels. R. Reinicke. *Phys. Zeits.* 30. *pp.* 693–697, *Oct.* 15, 1929.

Details of construction and directions for use of a model for giving a pictorial view of energy levels, selection rules, isotopes, etc., in atomic theory. G. C. McV.

915. Dynamic Atom Model of First Eleven Elements of Periodic Table. J. G. Black. *J.O.S.A. and R.S.I.* 19. *pp.* 317–319, *Nov.*, 1929.

A dynamic model of a Bohr atom is described, the model being capable of representing all of the normal and many of the excited configurations of the first eleven elements of the periodic table. The nucleus and all of the electrons are suspended in space on jets of air and are moving some in circles and some in paths resembling ellipses. About fourteen important concepts of the Bohr atom are brought out by the model, among them being the electron grouping, the progression of perihelion, the spinning electron and the quantisation of the spin axis in space. AUTHOR.

916. Rotational Instability and Uncoupling of the Electronic Orbital Angular Momentum from the Axis in Diatomic Molecules. W. W. Watson. *Phys. Rev.* 34. *pp.* 1010–1014, *Oct.* 1, 1929.

A number of peculiar rotational phenomena exhibited by some molecular spectra are attributed to uncoupling of the electronic orbital angular momentum from the nuclear axis. The details of several diatomic hydride band systems are discussed as examples. This uncoupling would contribute to a condition of rotational instability, and is a factor in limiting the amount of rotational energy that these molecules can possess in these electronic states. AUTHOR.

917. Statistical Theories of Matter, Radiation and Electricity. K. K. Darrow. *Bell System Techn. J.* 8. *pp.* 672–748, *Oct.*, 1929.

The atomic or "kinetic" theory of gases, with its interpretations of such qualities as temperature, pressure, viscosity and conductivity, has ranked for more than half a century as a very important part of theoretical physics. A corresponding theory for radiation and for negative electricity is much to be desired, since it is known that in many ways each of these entities behaves as though it were atomic. There are, however, differences among the three, and only within the last five years have these been formulated suitably. This article is devoted to the resulting statistical theories. AUTHOR.

918. B-State of Hydrogen Molecule. C. Zener and V. Guillemin, Jr. *Phys. Rev.* 34. *pp.* 999–1009, *Oct.* 1, 1929.

An attempt has been made to develop a wave function for the B-state of the hydrogen molecule using the variation method. The procedure adopted was only partially successful, as indicated by the discrepancy between the computed energy of dissociation, 2·64 volts, and the value obtained from band spectrum data, *viz.*, 3·37 volts. The form of the wave-function indicates that the B-state is partially, but not wholly, polar. Incidentally a method has been developed for the integration of

$$\int_1^\infty d\lambda_1 \int_1^\infty d\lambda_2 Q_\tau \begin{pmatrix}\lambda_1\\ \lambda_2\end{pmatrix} P_\tau \begin{pmatrix}\lambda_2\\ \lambda_1\end{pmatrix} \lambda_1^m \lambda_2^n e^{-a_1\lambda_1 - a_2\lambda_2}, \quad \begin{pmatrix}\lambda_1 > \lambda_2\\ \lambda_2 > \lambda_1\end{pmatrix}$$

an integral occurring in $\int\psi(1/r_{12})\psi dV$ when elliptic coordinates are used. [See also Abstract 1839 (1928). AUTHORS.

919. Mechanism of Emission and Melde's Experiment. L. Décombe. *Comptes Rendus*, 188. *pp.* 684–686, *Oct.* 28, 1929.

Supposes that an electron may move in a perturbed orbit which cuts the unperturbed elliptical orbit 4, 6 . . . 2*p* times, the appearance of the orbit resembling that of a string vibrating transversely, and giving one of the harmonics. The vibrations of the orbit would have to be kept up in a manner similar to that in which the vibrations of the stretched string are kept up by the tuning fork in Melde's experiment. The author makes use of the idea of pulsating electrons and protons, and comes to the conclusion that the emission of radiant energy is due to oscillations which the stable orbits undergo about their normal positions when a perturbing cause has accidentally displaced them. H. N. A.

920. Quantitative Considerations on the Structure of the Benzene Ring. R. Reinicke. *Zeits. f. Elektrochem.* 35. *pp.* 780–789, *Oct.*, 1929.

From the dimensions of the space lattice of the diamond and from a new methane model based on a strictly tetrahedral arrangement of the valency directions of carbon, space models for benzene and its derivatives are deduced, with numerical data concerning the reciprocal positions of the six carbon atoms and of the six hydrogen atoms in agreement with the experimental data. A number of physical data are cited in support of the new structure. T. H. P.

921. Unimolecular Layers of Cyclic Ketones. E. H. Büchner, J. R. Katz and P. J. P. Samwel. *Zeits. f. phys. Chem.* 5. *Abt. B.* 5. *pp.* 327–332, *Oct.*, 1929.

Many cyclic ketones spread on water in unimolecular films, the thicknesses of which have been measured. The results obtained indicate that the molecules of these ketones contain two parallel carbon-atom chains as suggested by Ruzicka. T. H. P.

922. Quantum Theory of Valency. W. Heitler. *Phys. Zeits.* 30. *pp.* 713–716, *Oct.* 15, 1929. *Paper read before the Theoret. Physikal. Conference, Charkow, May*, 1929.

Works out by means of the quantum theory expressions for the energy of perturbation when two hydrogen atoms approach one another, the exchanged energy E_Q, the classical Coulomb reciprocal action of Schrödinger's charge cloud, and the two different resulting reciprocal actions E_+ and E_-. One case, E_+, gives the possibility of molecular formation, while E_- gives only repulsion. Considers the relation between the energy E_Q and the spin, when this is parallel and when it is antiparallel, and shows that when the electrons have parallel spin a coupling energy $-E_Q$ exists. This may be the case with hydrogen, but not with helium. The coupling forces have exactly the typical properties of the valency forces. The theory is discussed for higher valencies than one, and is shown to be equivalent to the Lewis electron pair theory. H. N. A.

923. Dynamic Allotropy of Selenium. Parts I and II. G. Briegleb. *Zeits. f. phys. Chem.* 144. *Abt. A.* 5–6. *pp.* 321–358, *Nov.*, 1929.

Part I. X-ray examination confirms the amorphous nature of the vitreous solids quenched from the molten state. Quenched specimens are subjected to continuous extraction at a constant rate with cold carbon disulphide. The solution velocity varies as the extraction proceeds as a result of a change in the inner equilibrium of the vitreous selenium during extraction. The results are accounted for by the existence of two components: Se″, which dissolves rapidly in carbon disulphide, and Se′, which dissolves only very slowly. An equilibrium is, therefore, set up, at any one temperature, in the liquid, the Se′ content increasing with rising temperature, the composition of the melts, with respect to Se′ and Se″, being independent of the nature of the solid originally fused.

Absorption spectra reveal a change in the state of solution with increasing dilution. X-ray measurements of all the solid phases of selenium show that " metalloid " SeA is produced at 100° C. both from vitreous and from red monoclinic selenium. The " metalloid " SeA and the " metallic " SeB, obtained at 170° C. to 180° C. are structurally identical, differing only in grain size. Part II. The complete theory of the transformations in liquid and solid selenium is established. The two forms Se″ and Se′ are identified as a dipolar component Se_2 and a uniatomic component Se_1 respectively. The vitreous form is a solid solution of Se_2 and Se_1; red amorphous selenium is pure Se_2. The allotropic transformation from monoclinic to hexagonal selenium corresponds to a change from a dipolar molecular lattice to an atomic lattice. An equilibrium diagram is worked out for the liquid and solid phases, while the relations in solution are represented by a pseudo-ternary isothermal diagram. A. J. M.

924. Some Properties of Groups of Wave Disturbances. L. Natanson. *Acad. Polonaise Sci. et Lettres, Bull.* 4–5A. *pp.* 213–223, *April–May*, 1929. *In English.*

Considers the subject of group propagation, with reference to L. de Broglie's treatise on Wave-Mechanics. H. N. A.

925. Wave Mechanics Two Components Theory. E. Reichenbächer. *Zeits. f. Physik*, 58. 5–6. *pp.* 402–424, 1929.

Dirac's notion of developing differential equations of the second order for material waves from similar equations of the first order is shown to be valid if the analysis is restricted to two components of the wave function. The number, 4, representing the dimensions of the space-time universe is shown to be intimately related to the number, 2, representing the order of the resulting wave equations for each component. Dichotomy characterises not only zero order members of the wave equation but also first order members under certain conditions. J. S. G. T.

926. Equations of Wave Mechanics. J. Ullmo. *J. de Physique et le Radium*, 10. *pp.* 406–420, *Nov.*, 1929.

The hypothesis that matter can interact with an external electromagnetic field of force only at intervals of action equal to h, is shown to impose on the external field a fictitious wave equation of the second order in which occurs the Hamiltonian action S of an " exploring " electron, *i.e.* of an electron in the field which does not disturb the field. The action S is supposed to satisfy the Hamilton–Jacobi equation of classical mechanics. To get an equation describing the external field alone, S must be eliminated from these two equations. To do this the "fictitious" second order wave equation is replaced by four first order equations and S is eliminated; the result is the relativity equations of Dirac. From a solution of these last equations the permissible values of S are calculated, and hence the possible momenta and energy of the exploring electron. Since the initial position of this electron is unknown, these values of the momenta and energy at a point are interpreted statistically as the probabilities of the electron possessing such values at the point. Special discussions of Schrödinger's equation, the Davisson and Germer diffraction experiment and the distinction between " real " and " exploring " electrons are also given. " Real " and " exploring " electrons are equivalent when the former lie in stable orbits since, when in these orbits, they must be supposed not to affect the external field. G. C. McV.

927. Quantum Mechanics of a Gas in Fields at an Angle to Each Other. K. F. Niessen. *Zeits. f. Physik*, 58. 1–2. *pp.* 63–74, 1929.

Statistical mechanics applied to the determination of the change in the electric polarisation of a gas under the influence of a strong magnetic field. The electric polarisation is due to an electric field making an angle with the magnetic field. The molecules of the gas are assumed to be rigid, so that their magnetic and electric moments are constant. Also the gas as a whole is supposed not to show a polarisation in any direction. The change in the polarisation is shown to be the same as that calculated on the classical theory when the electric and magnetic fields are parallel; in all other cases it is greater. [See also Abstract 1986 (1928).] G. C. McV.

928. Quantum Theory as a Problem in Lines of Force. C. D. Niven. *Phil. Mag.* 8. *pp.* 491–504, *Oct.*, 1929.

The author states that practically no attempt has been made to give a physical explanation of the quantum theory, and in this paper he endeavours to express a point of view with respect to this theory. First, a detailed description is given of the operation of the Hertzian oscillator, following which comes an application to the Bohr model of the atom and the emission of light from discharge tubes. If there is any truth in the idea of electrons becoming attached and detached in the latter phenomenon, something of the same nature should take place when band spectra are emitted; and it seems reasonable to suppose that, instead of electrons attaching themselves, charged atoms or groups of atoms attach themselves. In the case of homopolar molecules, the two atoms are hard to separate and they consequently have to become attached in couples at a time. Further applications to thermal radiation, the photoelectric effect and conduction are discussed. The author's conception of a metal, which does not agree with the usual free electron theory, is expounded at some length. H. H. Ho.

929. Connection between Einstein's Theory of Distant Parallelism and Five-Dimensional Field Theory. H. Mandel. *Zeits. f. Physik*, 56. 11–12. *pp.* 838–844, 1929.

In passing from the Riemannian five-dimensional transformation formula (in the cylinder R_5) to the four-dimensional, in the $(X_1 - X_4)$ pseudo projection, one obtains a non-symmetrical four-dimensional transformation which can be identified with Einstein's. The correct gravitation equations follow from it. W. S. S.

930. Einstein's Unitary Field Theory. I. Tamm and M. Leontowitsch. *Zeits. f. Physik*, 57. 5–6. *pp.* 354–366, 1929.

(*a*) It is pointed out that in the new theory the field equations do not yield a spherically symmetric solution corresponding to the field of a charged particle at rest. This probably means that the simplest solution of Einstein's field equations corresponding to a charged particle at rest is characterised by axial rather than spherical symmetry, thereby taking account of the electron spin. (*b*) The known method for arriving at the equations of motion of a particle, which rests on the notion of zero divergence of the material energy-tensor, is shown to lead on the new theory to the equations of the geodesic, in which no account is taken of the Lorentz force on the charged particle, precisely as in the older theory. W. S. S.

931. Einstein's Unified Field Equations and the Schwarzschild Solution. M. S. Vallarta. *Nat. Acad. Sci., Proc.* 15. *pp.* 784–788, *Oct.*, 1929.

The nature of the gravitational field derived from the first form of the field equations suggested by Einstein in 1929 [see Abstract 70 (1929)] is investigated. The field equations do not yield the Schwarzschild solution. While space-time is not flat, space alone is Euclidean. [See also Abstract 2690 (1929).] J. S. G. T.

932. The Spherically Symmetrical Statical Field in Einstein's Unified Theory: A Correction. N. Wiener and M. S. Vallarta. *Nat. Acad. Sci., Proc.* 15. *pp.* 802–804, *Oct.*, 1929.

The analysis employed in a previous paper [see Abstract 2690 (1929)] is corrected, Cartesian local coordinate axes and Cartesian Gaussian coordinates in the continuum being now employed. None of the conclusions of the previous paper is shown to be invalid, but some of the final formulæ acquire an additional term. J. S. G. T.

933. Form and Substance. G. Rumer. *Zeits. f. Physik*, 58. 3–4. *pp.* 273–279, 1929.

Kantian discrimination between form, *i.e.*, space-time extension, and substance, *i.e.*, qualitative content, is examined in the light of an analysis of Einstein's equations $R_{ik} = 0$, which whilst leading to a unified field theory afford no new hypothesis as to the structure of space. The analysis indicates that the idea of emptiness is related to the reference space in much the same way as the idea of rest is related to the system of reference. The concept of substance has only a relative significance. J. S. G. T.

934. Unified Field Theory. R. Zaycoff. *Zeits. f. Physik*, 58. 3–4. *pp.* 280–290, 1929.

Various possible forms of Hamiltonian function appropriate to Einstein's unified field theory, and the resulting field equations are discussed. A unified theory is developed along the lines of the work of Ricci and L. Civita. [See also Abstracts 521 and 528 (1930).] J. S. G. T.

935. Basis of a Field Theory. K. Novobatzky. *Zeits. f. Physik*, 58. 7–8. *pp.* 556–561, 1929.

A mathematical study of the coefficients of connection and field equations of a class of generalised geometries which include that of Riemann. They allow of the introduction of electromagnetic quantities, but Einstein's gravitational equations and the conception of an energy-tensor remain unaltered. G. C. McV.

936. Various Connections of Functional Space. A. Kawaguchi. *Comptes Rendus*, 189. *pp.* 436–438, *Sept.* 23, 1929.

Affine, metric, symmetric and generalised Riemannian connections in functional space of zero order are very briefly discussed. J. S. G. T.

937. Theoretical Bases of the Law of Gravitation. J. le Roux. *Comptes Rendus*, 189. *pp.* 525–526, *Oct.* 7, 1929.

Considering *n* free massive particles in a finite space of 3*n* dimensions the author shows that the Newtonian law is alone compatible with stability of the system and at the same time satisfies certain postulates, *viz.*, the existence of the principle of least action, minimum values of the integral of energy due to acceleration, and kinetic energy, and continuity. J. S. G. T.

METEOROLOGY, GEOPHYSICS AND ASTROPHYSICS.

938. Distribution of Brightness in the Sky. G. I. Pokrowski. *Phys. Zeits.* 30. *pp.* 697–700, *Oct.* 15, 1929.

Derives a formula for the brightness of a given point of the blue sky as a function of the angular altitude above the horizon and the angular distance from the sun. The isophotes are calculated and plotted in diagrams. These curves are compared with those obtained experimentally by Dorno for different positions of the sun, and good agreement is found. H. N. A.

939. Diurnal and Nocturnal Measurements of Quantity of Ozone in Upper Atmosphere. D. Chalonge and F. W. P. Götz. *Comptes Rendus,* 188. *pp.* 704–705, *Oct.* 28, 1929.

Measurements were made by day at Arosa (1856 m.) where the sky is sufficiently clear to allow of this all the year round, with the Chalonge spectrograph [see Abstract 1192 (1928)], and also with that of Dobson [see Abstract 1532 (1926)]. A systematic difference was found, the indications of the latter being uniformly lower. Measurements were also made with Chalonge's instrument on a series of consecutive days and nights. From these results and those previously obtained [see Abstract 2933 (1928)] it is concluded that in these latitudes the presence or absence of the sun has no effect on the thickness of the layer of ozone. C. A. S.

940. Bibliography of Seismology. E. A. Hodgson. *Dominion Observat., Ottawa, Publ.* 10. *No.* 1. [17 *pp.*], *Jan.–March,* 1929.

941. Periodic Rayleigh-Waves Caused by an Arbitrary Disturbance. K. Sezawa. *Tokyo Univ. Earthquake Research Inst., Bull.* 7. *pp.* 193–206, *Sept.,* 1929. *In English.*

In continuation of previous work [see Abstracts 853 and 2090 (1928)] the author discusses the dispersion of Rayleigh-waves on the surface of a stratified elastic body, the velocity of propagation of the wave-phase depending upon the square and lower powers of the wave-length. The surface wave generated by a single disturbance at the origin of a semi-infinite dispersive medium are of harmonic type and the leading part of the wave-train is propagated with the velocity of a special Rayleigh-type wave. The periods of successive oscillations increase gradually, whilst the amplitudes in the case of the two-dimensional problem decrease gradually, and more rapidly in the case of three dimensions. The periods depend on the elasticities, effective thickness and dispersive constants of the medium. In some dispersive media there are abnormal regions of earthquake movements at certain periodic distances from the epicentre.
J. S. G. T.

942. Forerunners of Earthquake Motions. T. Matuzawa, K. Yamada and T. Suzuki. *Tokyo Univ. Earthquake Research Inst., Bull.* 7. *pp.* 241–260, *Sept.,* 1929. *In English.*

A further study has been made of the forerunning waves in 12 earthquakes having different epicentral depths and distances. Some waves other than those of the P and $\overline{P}$ phase are defined with considerable certainty even by deep-seated earthquakes with an origin below the second layer. The authors consider these are mainly caused by the mechanism of propagation rather than in the generation of the earthquakes. [See Abstract 2092 (1928).] R. S. R.

943. $\overline{S_cP_cS}$. I. Lehmann. *Gerlands Beitr. z. Geophys.* 23. 4, *pp.* 369–378, 1929. *In English.*

The $S - P$ records for 11 large earthquakes which occurred during 1921–25, and for which several records have been obtained for distances of 85°–95°, have been examined, and records of the phase $\overline{S_cP_cS}$ (Turner's [S]) distinguished from those of S_n. Rejecting all doubtful cases it is shown that for distances of 86°–95° $\overline{S_cP_cS} - P$ is practically uniform and equal to 10 min. 30 sec. $\overline{S_cP_cS}$/distance and S_n/distance curves cross at 86°, beyond which point it has been impossible to trace S_n with certainty. The variations for different earthquakes are, however, such as to indicate that the times of the phases vary from one earthquake to another in an unexplained fashion. C. A. S.

944. Tides on a Two-Layer Earth. L. Rosenhead. *Roy. Astron. Soc., M.N., Geophys. Suppt.* 2. *pp.* 171–196, *Oct.,* 1929.

The paper is largely a revision of Street's results [see Abstract 481 (1926)] in the light of the further knowledge of the constitution of the earth since obtained [see Abstracts 2288 (1926) and 3288 (1929)]. On the assumption that the earth, radius a, consists of a core, radius $0\cdot545a$, density $12\cdot04$, rigidity zero, and a shell, density $4\cdot27$, rigidity $1\cdot695 \times 10^{12}$ dynes/cm.^{2}, the effect of its rotation is calculated to produce ellipticities of the surface of an ocean of depth small compared to a, and of the submerged earth of 1/410 and 1/940 respectively. These values are respectively approximately identical with, and ⅓ of, those for a homogeneous earth of the rigidity of steel. For oceans of depths 7260 and 29,040 ft., the slowest symmetrical free oscillations expressible as a series of even zonal harmonics have periods of 18 hrs. 11 min. and 12 hrs. 35¾ min. respectively, as compared with 18 hrs. 3½ min. and 12 hrs. 28½ min. deduced by Hough for a rigid earth. The values of Love's numbers h and k are calculated according to the various theories, and it is shown that those deduced from long-period tides appear to indicate that these tides can be accounted for by the equilibrium theory. C. A. S.

945. Atmospheric Pressure and Tides. J. Proudman. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 2. *pp.* 197–209, *Oct.,* 1929.

The effects of changes in atmospheric pressure on the motions of the sea are worked out for three cases, namely: (1) a narrow channel of uniform depth with currents in one direction; (2) a channel whose depth varies from side to side but in which the conditions are uniform along its length; and (3) a sea of uniform depth but of unlimited extension in all directions. The rotation of the earth is taken into account, but friction and the action of the wind are neglected. W. A. R.

946. Forced Tides. J. Proudman. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 2. *pp.* 209–213, *Oct.,* 1929.

Formulæ are derived for forced tides in an ocean bounded by a complete meridian on a non-rotating earth. In the case considered the bounding meridians are separated by 180° of longitude, and the solution is given for all depths. When this solution is expanded in the customary variables, the resulting series do not converge on the equator. W. A. R.

947. Tides in Rotating Elliptic Basins. S. Goldstein. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 2. *pp.* 213–231, *Oct.,* 1929.

The dynamical equations of tidal motion in a rotating elliptic basin of uniform depth are solved. The equation for the periods of the free oscillations has the form of the vanishing of an infinite determinant whose elements involve the modified Mathieu functions. Both positive and negative waves are possible. Whereas the periods of the negative waves all decrease with increasing rotation, the periods of certain positive waves, including the slowest, increase towards unity. Experimental tests for free oscillations gives satisfactory agreement with the theory. W. A. R.

948. International Ellipsoid of Reference Tables. G. Perrier. *Comptes Rendus,* 189. *pp.* 506–509, *Oct.* 7, 1929.

Many terrestrial ellipsoids have been computed in the last two centuries, some from triangulations together with astronomical observations, some from determinations of gravity, resulting in a certain amount of confusion. Triangulations made in different countries must, in practice, be compared at the common frontiers, and the author indicates that here the measured bases must be brought to a common scale, referred to a common astronomical station, and to the same ellipsoid. The first of these is now done universally, but the other two are rarely taken into account. For the sake of such unification the section of the Geodesical and Geophysical Union, in its Session at Madrid in 1924, adopted as its standard Hayford's ellipsoid (*Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy,* Washington, Government Printing Office, 1910, p. 77) with semi-major equatorial axis = 6·378,388 km. and flattening = 1/2970. The author describes Hasse's tables for the values of the ellipsoidal elements for all latitudes, and Väisälä's for latitudes 59° to 70°, and also those made from the formulæ of Benoît. A. S. D. M.

949. Form of Volcanoes. T. Terada. *Tokyo Univ. Earthquake Research Inst., Bull.* 7. *pp.* 207–221, *Sept.,* 1929. *In English.*

Characteristic profiles of nine large volcanoes were prepared by averaging for each volcano 16 sections drawn from the summit for 40 km. outwards at intervals of 22·5°. One average profile for all the volcanoes is thence deduced. This shows a circumferential depression, deepest about 15 km. from the summit. This outline is discussed and shown to be not incompatible with its being partially due to yielding of the crust under the weight of the mountain. The possible connection of certain lakes in an elevated region with a volcano in one of depression, and of both with possible change of density below the surface is also suggested. C. A. S.

950. Correction of Time Signals. E. Andersen. *Gerlands Beitr. z. Geophys.* 23. 4. *pp.* 356–368, 1929.

In the course of measurements of gravity in Denmark in 1928 the author found that the corrections given by different institutions for the same time signals showed systematic differences. A close investigation of these shows that the differences can be separated into different periods, a short one of 12 days, and one or more longer ones whose length cannot yet be found. Daily variations of the correction differences have been established. The investigation has been applied to the determination of the chronometer rate by means of W/T time signals from different stations and for finding the larger errors in the lists of corrections.

R. S. R.

951. Ionisation and the Spectrum of Sunspots. M. Conti. *N. Cimento*, 6. *pp.* 289–297, *July*, 1929.

Investigation of recent results in ionisation, the fundamental data and their application to the spectra of the sun, from which it is shown that the atoms of different elements are, in differing degree, more ionised in the photosphere than in the sunspots. A. D.

952. Interpretation of the Absorption Spectrum of the Sun's Atmosphere. L. A. Sommer. *Zeits. f. Physik*, 58. 7–8. *pp.* 573–576, 1929.

Shows by means of the quantum theory, that the spectral lines in the absorption spectrum of the sun's atmosphere are due to transitions between deep-lying metastable terms in the atom spectra of nitrogen and oxygen. R. C. F.

953. Elements Unidentified or Doubtful in the Sun. C. E. St. John. *Astrophys. J.* 70. *pp.* 160–174, *Oct.*, 1929.

Elements unidentified in the sun are as follows: argon, actinium, arsenic, gold, bismuth, bromine, chlorine, fluorine, mercury, iodine, iridium, krypton, masurium, neon, osmium, phosphorus, protoactinium, polonium, radium, rhenium, radon, selenium, tantalum, tellurium, thorium, uranium, xenon, and the rare earths, holmium, illinium, lutecium, terbium, and thulium. The following are suggested for laboratory investigation: arsenic, iridium, osmium, phosphorus, tantalum, thorium, thallium, uranium and the rare earths. Study of these elements promises immediately useful information. For immediate application to problems of identification we need accurate determinations of the wave-lengths of critical lines and a study of their relative intensities and appearance under varied conditions of excitation. For general purposes we require precision wave-lengths throughout the spectral ranges of the different elements, preferably in vacuum, and analyses of the respective spectra. AUTHOR.

954. Solar Elements. C. E. St. John. *Nat. Acad. Sci., Proc.* 15. *pp.* 789–793, *Oct.*, 1929.

For the basis of identification the author gives: (1) Coincidences. The original identifications of the Fraunhofer lines in Rowland's tables depend upon the agreement in position of solar and laboratory spectral lines. (2) Absorption lines and excitation potentials, which he defines. For any element the absorption lines, arising through transitions from the lowest to the next higher level with which it combines, are the ultimate or resonance lines, and these are the most probable of occurrence in the sun if they come in the region of the spectrum observable, so that excitation potential furnishes a criterion of the probability of occurrence. (3) Multiplet relations. For many lines these furnish an estimate of the probability of their presence in the solar spectrum. (4) Behaviour in spots, stars and flash spectra. For many elements the appearance and relative strength of their lines in the spectra of disc and spots are characteristic. The enhanced lines are notable in high chromospheric layers (eclipse spectra) and in the reversing layer (flash spectra). (5) Pressure and temperature classes. The author gives four tables: (1) Of elements identified in the sun and their position in the periodic table; of which possible 92 elements, 90 have been found on the earth and 58 in the sun.

(2) Percentage of identification for intensity groups; some strong, unidentified lines seem to indicate exceptional conditions of excitation in the sun. (3) Average excitation potential for non-metals; this indicates an extensive solar hydrogen atmosphere. (4) The increase of percentage of ionised lines with decrease of energy level; the ionised helium line $\lambda 4686$ in the chromosphere is anomalous and points to an extraordinary condition of excitation in a relatively high layer of the solar atmosphere.
A. S. D. M.

955. Some New Laws for the Solar System. W. M. Malisoff. *Science*, 70. *pp.* 328–329, *Oct.* 4, 1929.

The author cites A. E. Caswell's suggested law that "the mean distances of the planets from the sun are proportional to squares of simple integral numbers and raises three objections." He points out a relation depending strictly on the square root of the distance of a planet from the sun or a satellite from its planet, namely, "The velocities of the planets are inversely in proportion to simple integral numbers." Thus, for Mercury–Neptune, taking $30 \cdot 3$/mean velocity, he obtains the integers, 3, 4, 5, 6, 11, 15, 21, 27; the same integers are obtained from Kepler's third law and the distance relation, namely, "the periods of the planets are proportional to the cubes of simple integral numbers." He draws attention to Viktor Goldschmit's work published in *Annalen der Naturphilosophie*, Vol. V. pp. 51–118, showing that the distances of the planets are quite closely in the sequence 1/13, 1/7, 1/5, 1/3, 1, 2, 3, 4. A mathematical treatment strictly analogous to the phenomena of standing waves in sound, the distribution of lines in spectra, the progress of crystallisation, gives the same law of harmonic relations of distances of planets and also of satellites, and he states certain harmonic sequences. The author himself advances the theory that considering the accurate correspondence of the velocity of a planet or satellite inversely to the square root of its distance from the axis of revolution, we may conceive the propagation of a wave of velocity at the initiation of revolution to follow the law of a logarithmic spiral, and he proposes that a small integral number of geometric means will determine the positions and velocities of all the planets and satellites; $\log d = nk$ gives a fairly accurate straight line plot for values $n = 1, 4, 5, 7, 10, 13, 16, 19, 21$, for the planets from Mercury to Neptune.
A. S. D. M.

956. Measurement of the Inclination of Axis of Rotation of a Transit Instrument in Time Determinations. G. Bigourdan. *Comptes Rendus*, 189. *pp.* 505–506, *Oct.* 7, 1929.

The inclination of the axis of rotation is measured usually by either the nadir method or a spirit level. The latter is simple, but capricious, and sometimes gives erroneous results whose origins cannot be traced; on the other hand, in the nadir method questions of illumination are raised. The author suggests that both methods should be employed as far as possible simultaneously so that one may control the other and a weighted mean taken of the results where different. He points out that the world-wide longitude determinations of 1926 November–December will allow of a consideration of these methods used by world-wide observatories at a given moment; out of 49 transit instruments employed, 8 used the nadir method, 39 the spirit level, and 2 both methods.
A. S. D. M.

957. Mechanics of the Chromosphere. W. H. McCrea. *Roy. Astron. Soc., M.N.* 89. *pp.* 718–730, *Oct.,* 1929. *Supplement.*

Milne's theory of selective radiation-pressure in the case of ionised calcium for the chromosphere is too special for hydrogen and helium, which are in relatively great abundance. The author discusses the problem of the hydrogen chromosphere [see Abstract 2403 (1929)] and finds that hydrogen is not in statical equilibrium, but when this restriction is removed there is a simple explanation allowing for the observed turbulence of the gas. Rosseland has suggested in eruptive prominences [see Abstract 1115 (1929)] actual transformation of laminar into turbulent motion, and Unsöld found that contours of H and K of Ca^+ in emission and H_3, K_3 in absorption could only be explained by a Doppler effect of 15 km./sec. [see Abstract 2696 (1929)], which expresses the mean velocity of the turbulence. He defines turbulent motion, supposing that the gas is divided in volume elements (of gas not space) Δ, such that, except for a small fraction, each contains a sufficiently large number of particles, the molecules' motion relative to the element is completely chaotic, and is described as by temperature T, the same for all molecules. The definition applies approximately to the chromosphere. If c^2 is the mean square velocity of the turbulence then an "apparent temperature" $\mathbf{T}_j = \mathrm{T} + \frac{1}{3}m_j\mathrm{C}^2$ for each molecular type j, and the pressure gradient under gravity will usually correspond to $\mathbf{T}j$, not T, but this must be modified for an ionised gas; and he finds C = 18·4 km./sec. He gives a numerical application to hydrogen. Apart from ionisation difficulties, the theory gives density gradients for all elements approximately of the same order as for hydrogen, and so explains how they penetrate the chromosphere. Since turbulence does not degenerate into heat motion in the chromosphere this means that its gas is being changed continually, and that the turbulent atmosphere gradually sinks. This may be the downward motion observed by St. John. The prominences may originate the turbulence and maintain the supply of material. A. S. D. M.

958. Early History of Solar System on the Collision Theory. H. Jeffreys. *Roy. Astron. Soc., M.N.* 89. *pp.* 731–738, *Oct.,* 1929. *Supplement.*

On the theory of the formation of planets from the sun by collision with another star, it is mathematically proved that the ejected matter which eventually became the planets cannot have come from any considerable depth in the sun, but was swept off the surface without mixing with other solar or stellar matter and without transfer of heat to any important extent. This matter formed a ribbon-like mass, which would be unstable in a complicated way and would probably break up into planetary nuclei after a few hours. These nuclei expanded adiabatically when formed, and liquefied when their density was about 6×10^{-6} gm./cm³. This took about a day for the Earth and a week for Jupiter. The subsequent collection of the drops into liquid planets was controlled by radiation, and probably took some days for the Earth and a few years for Jupiter. It seems probable from several considerations that the satellites were formed at nearly the same time as the planets, not at a later date (as on the tidal theory); and the transverse ruptures which are likely to have occurred in the ribbon-like mass, as well as the longitudinal, offer the first hint of an explanation concerning the anomalous motions of the satellites of Uranus and Neptune. M. A. E.

959. Planetary Motion in a Retarded Newtonian Potential Field. R. J. Kennedy. *Nat. Acad. Sci., Proc.* 15. *pp.* 744–753, *Sept.*, 1929.

The notion of effective charge due to Liénard and Wiechert is applied to the gravitational field, and it is shown that the classical potential theory, incorporating this notion, is capable of accounting for the particulars of planetary motion about as accurately as does the theory of relativity. J. S. G. T.

960. Secular Variations of Orbital Elements of the Four Inner Planets. H. S. Jones. *Observatory*, 52. *pp.* 297–304, *Oct.*, 1929.

Attention is here drawn to the need of a reinvestigation of the motion of the node of Venus, which, since the motion of Mercury's perihelion was accounted for by relativity, remains the one outstanding discordance between observation and theory in the orbital elements of the inner planets. Newcomb's researches and results concerning astronomical constants are discussed. The material he employed for deriving the orbital elements of Venus included meridian observations from the middle of the eighteenth century to the year 1890, but the meridian observations before 1820 have a combined weight equal only to the weight of one year's observations since 1890. With the modern data now available a considerable improvement in the motion of the node of Venus could be obtained, and this is highly desirable. M. A. E.

961. Proper Motions of Six Planetary Nebulæ. K. Lundmark. *Arkiv f. Mat. Astron., och Fysik, Stockholm,* 21A. 8. [16 *pp.*] 1929. *In English.*

It is generally admitted that all the planetary nebulæ are within the galactic system, and that their nuclei belong to spectral class O. Ordinary class O stars are giants, with a mean absolute magnitude of about $-4\cdot0$. But the low mean absolute magnitude of about $+7\cdot7$ has been found for more than 20 planetaries whose parallaxes have been measured by van Maanen. To obtain the distribution of these nebulæ, the best means is to study their proper motions. These have been determined for six, from a collection of observations made by various observers in the course of the nineteenth century, and the results are given. It is hoped to derive proper motions for about 30 more planetaries, and general conclusions will not be made until then. M. A. E.

962. The Galactic Pole. P. Emanuelli. *Accad. Lincei, Atti*, 9. *pp.* 1096–1102, *June* 16, 1929.

A discussion of the galactic pole and the extra-galactic spiral nebulæ based upon the stellar chart of Franklin Adams and the photographic material of the Mount Wilson and Lick Observatories. Only 55 of the nebulæ enumerated are considered to be truly extra-galactic. Their minimum magnitude is the 18th. E. E. F. d'A.

963. Photographic Observations of Certain Jovian Phenomena Reported by Hargreaves, Peek and Phillips. W. H. Wright. *Roy. Astron. Soc., M.N.* 89. *pp.* 703–708, *Oct.*, 1929. *Supplement.*

800 images of Jupiter taken between Oct. 1, 1928, and Jan. 8, 1929, in colours between 3600 Å. and 7600 Å., by Moore and Chappell at the Lick Observatory, so as to test the alterations in the Red Spot and the disturbances in the South Equatorial Belt [see Abstract 1807 (1929)]. Two plates are given. Between Oct. 4 and 9 the Red Spot lengthened

and narrowed, the latter probably through the encroachment of a great white cloud to its north. By Oct. 22 it was invisible in ultra-violet, but bright in extreme-red; by Dec. 12 it was the brightest part of the planet in extreme-red. The backward-moving spots showed dark in all colours and, therefore, extended through all atmospheric layers, or else being in the uppermost layers were opaque to all deeper light. The forward-moving spots were involved in the great white cloud north of the Red Spot, and this cloud probably showed up as the "irradiating spot" when near Jupiter's limb, probably because it was specially rich in the shorter wave-lengths. The author traces this cloud and its longitude from Oct. 28·3 to Nov. 9·3, and finds that, as a whole, it moves forward about 5° a day, and its northern spurs about 7° a day; he considers it a high-level phenomenon. He suggests that in future observations note should be taken of bright spots near the limb as to whether the colour favours the more refrangible part of the spectrum consistently. A red or yellow spot at high altitude should not fade so rapidly towards the limb as do deeper colours, and on the limb itself should appear as an excrescence when photographed in its own colour; but as such do not appear to have been observed, these colours must occur only at considerable depths. [See also next Abstract.] A. S. D. M.

964. The Recent Disturbance on Jupiter. F. J. Hargreaves. *Roy. Astron. Soc., M.N.* 89. *pp.* 708–713, *Oct.*, 1929. *Supplement.*

A detailed account, with plate, of an extremely bright white spot, projecting apparently at Jupiter's limbs in the latitude of the South Equatorial Belt in the last few days of October, 1928. At first the author had not considered that any part of the long double-lobed very bright area observed on Oct. 25 between the components of the Belt could be responsible for the limb projection, but as the evidence was scanty regarding identity he gives it in detail, and concludes finally that one bright round spot seen in longitude 213°·7 (System I) may have been the "irradiating spot"; but he suggests that this spot had for a few days the property of becoming specially visible at a variable angle (in the neighbourhood of 70°) from the central meridian for a variable time, this angle being greater on the *preceding* side of the disc than on the *following* side, which property was lost before the spot began to fade. The observations are not inconsistent with the supposition that a temporary gap was present in an outer absorbing layer in the planet's atmosphere, in which the preceding edge was at a greater altitude than the following edge. He does not suppose that the irradiating object was ever seen at the true limb. He gives examples of *red* spots, unaffected by limb haze, appearing at considerable altitudes, which would, however, not be observed at the limb photographically because of their feeble luminosity. Blue and blue-green objects of low luminosity faded usually after passing the central meridian, and seem to lie at considerable depths. [See also Abstract 1807 (1929) and preceding Abstract.] A. S. D. M.

965. Spectrophotometric Temperatures of Early Stars. B. P. Gerasimovic. *Harvard Coll. Obs., Circ. No.* 339. [27 *pp.*], 1929.

An investigation of the spectrophotometric gradients of early stars relative to five bright standard A_0 stars. Short spectra (from H_α to H_ϵ is 3·2 mm.) were taken with the 24-in. reflector using the 24-in. objective prism of 6° angle and analysed by the Moll microphotometer. The exposures and, therefore, the spectra must be short, since important systematic errors are caused by defective standardisation or by sky transparency change. Wolf-Rayet and absorption O stars were determined from A_0 stars by measuring 11 points between H_β and H_ϵ. A table gives a catalogue of results, and the observed gradients are represented graphically, showing that the temperatures of early stars are not so high as has been supposed. The highest for an early B star is not greater than 18,000°, and some stars like SS Cygni have temperatures as low as 7000° or 5500°. The author's results (as well as recent Greenwich) tend to confirm the narrow Wilsing spectrophotometric scale which assigns a temperature of 12,300° to Class B_0 (the wide Rosenberg scale giving 30,000°), but are in striking discordance with the ionisation temperature scale. On the other hand the Wolf-Rayet stars appear to be very hot. The ionisation scale does not parallel the spectrophotometric because the exciting radiation appears to deviate from blackness, and spectrophotometric temperatures are of special meaning when the assumption of black body radiation fails. The cooler B_0 to B_5 stars are brighter than the hotter, and so are the O absorption stars than the hotter Wolf-Rayet; the Be stars have lower temperatures than the ordinary B, and are, therefore, absolutely brighter. There is low correlation between the observed gradients and Struve's cosmic K intensities. The abnormally low colours for O and B stars are due to scattering by local or general matter, or—more probably—are real and intrinsically associated with early stars, whose radiation must have large excess in the ultra-violet. He defines the atmosphere of such as "super-excited," and gives a tentative explanation of such phenomena in terms of the theory of the interstellar atmosphere. A. S. D. M.

966. Luminous Surfaces in Stellar Photometry. J. Dufay. *Rev. d'Optique*, 8. *pp.* 321–331, *Sept.*, 1929.

Plate photometers, similar to the universal Fabry and Buisson photometer with diffusing screen, give a better accuracy in the comparison of star brightnesses than those in which luminous points are compared, but they are not suitable for the study of faint stars. The difficulty of scintillation is greatly reduced when too bright surfaces are avoided. The accuracy of a single setting is about 3 %. As examples, measurements on the Pole Star, Algol and δ Cephei are given. F. S.

967. Elliptical Elements of the System of W Ursae Majoris. G. Viola. *Accad. Lincei, Atti*, 9. *pp.* 861–867, *May* 19, 1929.

The orbital elements of this variable have hitherto been deduced on the hypothesis of a circular orbit. The author calls attention to the ellipticity of the system as indicated by the light curve, which is confirmed by new reductions which he has made of the photometric and photographic results of various observers. The elements calculated on the hypothesis of ellipticity are given. The eccentricity of the orbit = 0·0103. Referred to the sun the densities of the components, supposed of equal mass, are 0·607 and 0·888 respectively, and similarly the radii are 1·211 and 1·077. J. J. S.

968. Variable Star H.V. 4585. Henrietta H. Swope. *Harvard Coll. Obs., Bull.* 868. *pp.* 12–14, *June* 1, 1929.

This star varies in magnitude between 14·8 and 16·3. Fifty of the observations discussed were made in the last five years, and the rest were scattered over 31 years. The period seems to be 69·5 days, but between September 1906 and May 1910 a change in phase occurred, which may have been caused by an unusually long minimum or maximum, or by a shortened interval between like phases. Since only two observations were made during the time when the change took place, it is impossible to say whether it was gradual, or sudden, or irregular. A series of 35 observations in 1926 show slight changes in form of light-curve. If this is a true Cepheid, with no-obscuring nebulosity before it, its distance must be over 70,000 parsec and the star would be one of the most distant objects in the galactic system. It seems to be very much like S Vulpeculæ, with similar range and length of period, and subject also to variation in period. M. A. E.

969. Radial Velocity of β Cephei. J. C. Duncan and Helen M. Mitchell. *Astrophys. J.* 70. *pp.* 127–130, *Sept.*, 1929.

From thirty-three spectrograms of β Cephei, obtained with the 60-in. reflector at Mount Wilson by Duncan on August 21, 1928, and measured at the Whitin Observatory by Miss Mitchell, the velocity-curve appears to be a sine curve of semi-amplitude 15·5 km./sec., with a superposed secondary oscillation of semi-amplitude 2·2 km./sec., and period half that of the main curve. The velocity of the centre of mass, earlier shown by Crump to be variable, is − 0·66 km./sec., the highest so far published. The period, which up to 1921 had appeared to be constant at 0·1904795 day, has certainly changed, and the observations here discussed may be brought into harmony with the Lick observations of 1921 by a period of either 0·1904838 or 0·1904722 day. AUTHORS.

970. Emission Lines Accompanying Absorption Lines in Stellar Spectra. W. H. McCrea. *Zeits. f. Physik*, 57. 5–6. *pp.* 367–379, 1929.

Discusses Franck's suggestion that repeated scattering of light in a stellar atmosphere might account for absorption lines, in cases where true absorption cannot exist, and also for absorption lines in certain stellar spectra with emission lines on the long wave-length edge. The idea has been worked out by Orthmann and Pringsheim, and the author carries out numerical estimates of the magnitudes involved in the theory. He finds that the known dimensions of the stars are not sufficient to produce an effect of this kind. The phenomenon of emission lines combined with absorption lines is simply explained by movement of gas. H. N. A.

971. Pressure Effects in Stellar Spectra. O. Struve. *Astrophys. J.* 70. *pp.* 85–104, *Sept.*, 1929.

As the lines of CII and SiIII are known not to be very susceptible to the Stark effect, stars were selected in which these lines are perfectly sharp. The lines of the diffuse series of helium in these stars are compared with other helium lines, and the difference of "haziness" is compared with the width of wings of hydrogen lines and the presence of the forbidden line λ4470. The wave-lengths of certain helium lines were measured and are compared with laboratory values, the differences corresponding with pressure shifts due to unsymmetrical Stark broadening. Some observations on the intensities of helium lines are also recorded. F. S.

972. Contours of Helium Lines in Stellar Spectra. C. T. Elvey. *Astrophys. J.* 70. *pp.* 141–159, *Oct.*, 1929.

The contours of He4472 and He4388 have been obtained for twenty-eight stars from spectrograms made with the three-prism spectrograph of

the Yerkes Observatory, and analysed with the registering microphotometer. The contours can be represented by an equation of the simple exponential type. The presence of the Stark effect is shown by the asymmetry of He4388 and by the "forbidden" line λ4470 of helium in the violet wing of He4472. "Dish-shaped" contours of the lines in the spectra of 16 λ Aql., 4 γ Cor., 19 *q* Tau., 44 ι Ori., and 22 λ Cep. indicate axial rotation of these stars. By Milne's theory, logarithms of the number of atoms responsible for producing an absorption line are computed for various assumptions of the physical properties of the stars. These are shown in the form of curves by plots of log $N_0^{(s)}$ against the temperature. The number of atoms NH*f* is determined for each star by using Unsöld's theory. To eliminate the Stark effect and the broadening due to rotation, NH*f* is determined by comparing the areas of the observed contours with those given by theory. A value of 0·1 was arbitrarily chosen for *f*, and the resulting numbers of atoms have been compared with the curves computed from Milne's theory. The observations support the assumption that the coefficient of absorption varies with the pressure, rather than that it is a constant. The observations indicate pressures of 783 dynes/cm.^{2} to 9270 dynes/cm.^{2} for *g* equal to 10^3 cm./sec.^{2}, the temperatures being from 10,000° to 30,000°. For *g* equal to 10 the pressures are 0·1 as large.
AUTHOR.

973. Spectrum of α^2 Canum Venaticorum. C. J. Anger. *Astrophys. J.* 70. *pp.* 114–126, *Sept.*, 1929.

The spectrum of α^2 Canum Venaticorum has been studied by means of traces made on a Moll microphotometer, and the intensities of lines have been measured and plotted with a view to detecting periodic variations. The existence of two groups of variable absorption lines has been confirmed, and periodic variation has been found for individual emission lines. Periodic variation has been found for lines formerly considered steady, and notably for lines not due to rare earths. The most important of these lines are Ca^+ 3933, Si^+ 4128, and Mg^+ 4481. The wave-lengths of emission lines have been measured.
AUTHOR.

974. Stellar Calcium Lines in Spectral Types A and B. O. Struve and C. D. Higgs. *Astrophys. J.* 70. *pp.* 131–134, *Sept.*, 1929.

The contour of the calcium line K was determined in four stars of class A. For α Lyræ the observed contour agrees well with the theoretical formula of Unsöld. The total number of atoms $N \cdot D = 3 \cdot 5 \times 10^{16}$. For α Cygni the agreement is not so good. An approximate fit gives $N \cdot D = 10^{17}$. The lines in α Aquilæ and α Ophiuchi are wide and shallow and cannot be represented by the Unsöld formula. The total number of atoms N·D was determined also from estimates of the central intensity of the K line in a large number of stars. The values range from 4×10^{16} for type A2 to 3×10^{15} for type B5.
AUTHORS.

975. Red Shift of Spectral Lines through Interstellar Space. F. Zwicky. *Nat. Acad. Sci., Proc.* 15. *pp.* 773–779, *Oct.*, 1929.

The bearing of the fact that very distant nebulæ show remarkably high receding velocities whose magnitude increases with the distance, upon the future development of cosmological theory is referred to. The principal facts to be accounted for by any cosmological theory and various theories advanced in explanation are discussed. Attention is directed to a new effect of masses upon light, having some of the characteristics of a gravitational analogue of the Compton effect.
J. S. G. T.

LIGHT.

976. Colour Changes in Rock-Salt. K. Przibram. *Akad. Wiss. Wien, Ber.* 138. 2A. 7. *pp.* 483–495, 1929.

On the basis of the hypothesis of three kinds of centres of change of colour of various grades of disturbance, a scheme of all the hitherto known phenomena of colour change in rock-salt is developed. This hypothesis depends on varied observations. A centre of change of colour is defined as an ion whose neutralisation gives occasion to the change of colour, together with its nearest surroundings which determine its mobility. A colour centre is defined as a neutral atom, together with its neighbouring necessarily disturbed surroundings, which determine its mobility and influence its absorption spectrum. J. J. S.

977. Absorption of Ultra-Violet Light by Oxygen, Water Vapour and Quartz. L. P. Granath. *Phys. Rev.* 34. *pp.* 1045–1048, *Oct.* 1, 1929.

Quantitative measurements were made of the absorption of light by oxygen, water vapour and crystalline quartz in the spectral region 1850 to 2300 Å., by means of a quartz spectrograph and a recording densitometer. Defining the absorption coefficient α by $I = I_0 10^{-\alpha d}$, where d is the distance in cm, values of α were obtained for oxygen at atmospheric pressure in tubes up to 5 m. in length, which showed the peaks of absorption due to the Schumann–Runge band system below 1970 Å. From 2000 to 2100 Å. the absorption appeared continuous with no marked peaks, α being 0·00025, 0·00032 and 0·00050 at 2100, 2050 and 2000 Å. respectively. The values of α for saturated water vapour at 25° C. were 0·0005, 0·0013, 0·003 for wave-lengths 2050, 1950 and 1900 Å. For a specimen of crystalline quartz 2·5 thick, α was found to be 0·086, 0·11, 0·13 and 0·17 for wave-lengths 2040, 2000, 1940 and 1870 Å. AUTHOR.

978. Influence of Adsorbed Ions on the Absorption of Light by Halides of the Heavy Metals. K. Fajans and G. Karagunis. *Zeits. f. phys. Chem.* 5. *Abt. B.* 6. *pp.* 385–405, *Oct.*, 1929.

In continuation of previous work on silver bromide [see Abstract 617 (1928)], it is found that the strength of the absorption of light by silver iodide (as a gelatin emulsion) for the band lying about 420 $\mu\mu$ as a maximum is considerably increased (up to 30 %) by adsorption of the excess of silver ions; the position of the maximum is not, however, appreciably altered. Thus, the fact that the primary process in the photochemical decomposition of silver iodide is influenced by adsorbed silver ions is dependent, not on a change of the active energy quantum, but on increase in the number of elementary processes. T. H. P.

979. Colour Vision. N. T. Fedorow and V. J. Fedorowa. *Zeits. f. Physik*, 57. 11–12. *pp.* 855–864, 1929.

The authors measured by the method of least steps the distribution of brightness in the spectrum for their normal eyes and for their eyes after the influence of very intense red and green rays which produced temporary red and green blindness. The investigation of the critical flicker fre-

quency shows that the constants *a* and *b* in Porter's formula are functions of λ and are changed by the fatigue of the eye on prolonged exposure.
E. E. F. d'A.

980. Weber's Law and Visual Acuity. R. A. Houstoun. *Phil. Mag.* 8. *pp.* 520–529, *Oct.*, 1929.

It is pointed out that the reciprocal of Fechner's fraction, $\frac{B}{\delta B}$, when plotted against log B, gives a curve closely resembling a probability curve. A theory is advanced to explain this shape assuming the percipient elements to be distributed at random in a medium through which the stimulating agency (*e.g.*, electrons) diffuses with loss by absorption. The higher the intensity of the stimulus the more percipient elements activated. The theory is also used in an attempt to explain the shape of the visual acuity-log B curve. The agreement is not complete and an explanation is put forward based on a so-called "contrast factor."
W. S. S.

981. Reflection Factor of Ground Surfaces. H. H. Kimball and I. F. Hand. *Monthly Weather Rev.* 57. *pp.* 291–295, *July*, 1929.

As the result of an international agreement at the Prague meeting in 1927 of the Union Géodésique et Géophysique Internationale (Section de Météorologie), four Richardson photometers were issued to different countries for use in making measurements from aeroplanes of the mean reflection factor of the earth's surface. The present paper describes the first set of measurements, made in the neighbourhood of Washington, D.C. Results are given in some cases with a red, green, or blue filter in the photometer and in some cases with no filter. The height of observation varied from 500 to 2500 ft. At the end of the paper tables summarising the results are given. Forest areas reflect about 5 % and grassy areas about 6 %. The ocean reflects about 7 to 9 % near shore and about 3 to 3·5 % 15 to 20 miles out. Rivers reflect about 7 to 9 %. [*Erratum, ibid.* p. 388, Sept., 1929.]
J. W. T. W.

982. Determination of Reflection Factors of Steel Mirrors. (Miss) J. Clavier. *Rev. d'Optique*, 8. *pp.* 379–391, *Oct.*, 1929.

Determines the reflection factors for four different stainless steel mirrors, from results obtained by means of photographic photometry. The wave-length range between which the factors are obtained is 3260 Å. and 5600 Å. An acetylene flame is used as the light source, whilst on each plate photographs are taken of four different known intensities, the reflection spectra of the steel mirror, arranged so that the densities are between those due to the known intensities, and a calibrating spectrum. The variations of the reflection factors produced by altering the composition of the steel, the state of polish of the surface, and the subjecting of the surface to atmospheric action, are also examined. In the determination of the accuracy of the results it is shown that the variations of the photographic plates and the inaccuracies thereby produced are easily the biggest sources of error. Finally, a brief description is given of attempts to silver the stainless steel mirrors.
R. C. F.

983. Metal Reflection. Optics of Alkali Metals upon Glass. I. Ebeling. *Zeits. f. Physik*, 58. 5–6. *pp.* 333–344, 1929.

The selectivity of thin coloured layers of potassium and rubidium in the near infra-red was measured and examined from the transmission spectrum. It remains undecided whether the absorption lines are created by the form factors, which for this kind of alkaline metallic skin or layer come into consideration (*i.e.*, particle size, particle distance apart, particle form, etc.), as set forth by Wood, Mie and Gans, or whether the band spectra are to be considered. The work and hypotheses of Gudden and Pohl, Ebeling and Wood are discussed in relation to the problem, whilst full experimental details are given. S. G. B.

984. Measurements of the Light Penetrating into the Second Medium in Total Reflection. O. Stasiw. *Ann. d. Physik*, **3.** 2. *pp.* 209–228, *Oct.* 8, 1929.

For the chemical action of light waves the electrical and not the magnetic forces are of importance. When a fluorescent substance is used to prove the existence of light penetrating into the second medium, it is not permissible to make use of the Poynting vector, since this contains the magnetic component, but the ratio between the squares of the amplitudes of the electrical forces must be employed in comparing the intensities of the penetrating light polarised perpendicular and parallel to the plane of incidence. The author arrives at an expression for this ratio, and the quantitative photometrical measurements lead to the result that this expression is practically satisfied, so that it appears that the phenomenon is not to be explained by means of the Poynting vector, but that agreement with Maxwell's theory exists on the assumption that only the electrical vibrations are in this case to be considered. The investigations were made using alcoholic solutions of a fluorescent substance, the ratio between the intensities being determined for a number of angles in the neighbourhood of the critical angle for total reflection. When the fluorescent substance was dissolved in glycerin, disagreements with the theory were observed, for which a provisional explanation is given. H. N. A.

985. Contributions to the Theory of Anisotropic Liquids. Parts VIII, IX and X. C. W. Oseen. *Arkiv f. Mat., Astron. och Fysik, Stockholm*, **21A.** 11. [35 *pp.*], and **21A.** 16. [17 *pp.*], 1929. *In German.*

These papers continue the investigation from Part VII, which derived differential equations that in the most general cases contained five material constants. The complete integration of these equations cannot as yet be accomplished, but Part VIII considers the special case of plane structures and Part IX that of the propagation of light through a helicoidal structure the rotation of which is parallel to the axis. Part X employs the considerations of Part IX for the special case of an inclined incident light wave. The whole of the investigation is entirely mathematical. H. H. Ho.

986. Theory of the Faraday Effect. L. Rosenfeld. *Zeits. f. Physik*, **57.** 11–12. *pp.* 835–854, 1929.

Using modern quantum mechanics, the theory of the Faraday effect is studied, and incidentally certain aspects of the Zeeman effect. Attention is confined to elements for which the spectrum has a normal multiplet structure. An Appendix calculates a second approximation to the intensity of the circular polarised components in the Zeeman effect. J. H. A.

987. Verdet's Formula for Intensity of Light through Two Crystal Plates between Crossed Nicols, and its Application to Measurement of Retardation in Crystal Plates. H. Brasseur. *Zeits. f. Krist*, **72.** 2. *pp.* 143–158, *Oct.*, 1929. *In French.*

A birefringent "test" plate of known retardation, $\Delta = \Phi\lambda/2\pi$, is placed between the plate to be examined (of retardation $\delta = \phi\lambda/2\pi$) and the analyser with its principal axis at 45° to the principal sections of the (crossed) nicols. The angle between the principal axes of the two plates being $\pi/4 - \epsilon$, and a the amplitude of the monochromatic light used, the intensity of the light after passing through the analyser is

$$a^2/2 \times [1 - \cos\Phi\,(\sin^2 2\epsilon - \cos^2\epsilon\,\cos\phi) + \cos 2\epsilon\,\sin\phi\,\sin\Phi].$$

Values of ϵ corresponding to maxima and minima of the intensity are determined, and from these those of ϕ and δ. Full details of the method are given with examples showing results in close agreement with those obtained with a Bérek compensator. The method is applicable only where retardation is independent (or very nearly so) of the wave-length, but is useful when it is too great for measurement by other methods.

C. A. S.

988. Measurement of Dichroism of a Plate of Known Retardation. H. Brasseur. *Zeits. f. Krist.* 72. 2. *pp.* 159–176, *Oct.*, 1929. *In French.*

A birefringent non-dichroic (or practically so, *e.g.*, a calcite quarter-wave) plate of known retardation $\Phi\lambda/2\pi$, is placed between the dichroic plate to be examined, of known retardation $\delta = \phi\lambda/2\pi$, and principal amplitudes h and v, and the analyser, with its principal axis at 45° to the principal sections of the (crossed) nicols. The angle between the principal sections of the two plates being $\pi/4 - \epsilon$, the intensity of the light after passing through the analyser is

$$\tfrac{1}{4} \times [(h^2 + v^2)\,(1 - \sin^2 2\epsilon\,\cos\phi) + 2(h^2 - v^2)\,\sin 2\epsilon\,\sin^2\phi/2$$
$$- 2hv\,\cos 2\epsilon\,(\cos 2\epsilon\,.\,\cos\phi\,.\,\cos\Phi - \sin\phi\,\sin\Phi)]$$

The dichroism of a plate of which the axes of absorption coincide with those of elasticity, measured by h/v, is $(k + \sqrt{k^2 + 4})/2$, where $k = 2\tan 2\rho\,.\,\sin\phi$, ρ being the value of ϵ less than $\pi/2$, for which I is a maximum or minimum. Full details and variants of the above formula are given, and the method is exemplified by determining the dichroism of plates of staurolite parallel to the faces (100) and (010) for light of various wave-lengths.

C. A. S.

989. Circular Dichroism. G. Bruhat. *Rev. d'Optique*, 8. *pp.* 365–378, *Oct.*, 1929.

The author summarises the facts relating to anomalous dispersion and circular dichroism of active coloured bodies as given by Cotton and the theoretical interpretation of these phenomena, including the rules stated by Natanson and himself. It is shown that the existence of the Cotton effect ought to depend on the chemical composition of the active coloured substance and the nature of the links in the interior of the molecule. It is emphasised that the essential fact of the Cotton effect is circular dichroism. Anomalies of dispersion can be hidden by the superposition of a normal dispersion and analogous anomalies can be produced in the absence of the Cotton effect by optical superposition.

R. S. R.

990. Theory of Magneto-Optical Phenomena in Crystals. J. Becquerel. *Zeits. f. Physik*, 58. 3–4. *pp.* 205–216, 1929.

The absorption spectra of crystals of salts of the rare earth elements contain many narrow bands or diffuse lines. These lines exhibit a Zeeman effect in a magnetic field, but of a different character from that observed in vapours. This difference is attributed to a Stark effect produced by the ions of the crystal lattice. The simplest case to consider is that in which the magnetic field is parallel to the crystallographic axis, when two subsidiary cases can be distinguished according as the beam of light is parallel to the axis, when there is only an "ordinary ray," or perpendicular to the axis when the "extraordinary ray" exhibits some novel characteristics in its response to the magnetic field. Brief reference is also made to the case in which the magnetic axis is not parallel to the crystallographic axis (which is presumably also that of the internal electric field), but the effects are here much less simple, and were recorded only to show the existence of complexities comparable with those produced in vapour by inclined electrostatic and electromagnetic fields as studied by Bohr. T. M. L.

991. Action of Polarised Light on Photographic Plates Prepared from Solutions of Colloidal Silver. A. Cotton. *Comptes Rendus*, 189. *pp.* 599–603, *Oct.* 21, 1929.

"Grainless" photographic plates, obtained by treating with cupric bromide solution a plate prepared by coating a glass slip with gelatin containing colloidal silver, are used in experiments on the Weigert phenomenon. The colourless plate so obtained becomes coloured on exposure for an hour to the beam of light from the condenser of an arc-lamp. Polarimetric observations in green mercury light show that the exposed plate is markedly dichroic, the effect being even more pronounced on plates treated with iodide instead of bromide. A similar, but weaker, effect can be produced by exposure to polarised monochromatic light. The heterogeneity of the structure of the modified medium containing ultramicroscopic grains of silver, which the Weigert phenomenon implies, may consist in an anisotropic distribution of the grains, or in an anisotropic structure of grains, distributed at random, but not having a random orientation. Weigert adopts the latter view, assuming the existence in the film of micellæ of silver, the form of which can vary systematically under the influence of polarised light. The alternative hypothesis, anisotropy of distribution, raises difficulties in connection with the change of sign of the dichroism and birefringence with wave-length, but would be preferable in some respects. The idea that photographic action is related to a photoelectric effect suggests that a plate exposed to polarised light in a magnetic field might show a difference in dichroism from a plate treated in the normal way. The experiment fails, however, to reveal any difference on exposure for thirty minutes in a magnetic field of 50,000 gauss. The hypothesis of anisotropic distribution is therefore not confirmed. If it is charged particles in motion which determine the distribution or structure of the reduced silver in the sensitive film, they must have a mass much greater than that of the negative electrons detached by a photoelectric effect. [See also next Abstract and Abstracts 1847 and 3313 (1929) and 115 (1930).] A. J. M.

992. Asymmetrical Synthesis and the Combined Actions of Polarised Light and a Magnetic Field on Certain Photographic Plates. A. Cotton. *Comptes Rendus*, 189. *pp.* 657–660, *Oct.* 28, 1929.

Zocher and Coper [see Abstract 1890 (1928)] have shown that a suitably sensitised plate acquires a rotatory power, with circular dichroism, on exposure to circularly polarised light. The plates previously used with success for plane polarised light [see preceding Abstract] having failed to become rotatory after exposure to circularly polarised light, it was found that Zocher and Coper's results could only be repeated by using Rochelle salt as the reducing agent to produce the silver film. The possibility of the results being affected by traces of the optically active Rochelle salt was disproved by experiments using Rochelle salt made from laevo-tartaric acid, and employing alternately left- and right-handed rays. The conditions of symmetry in the film modified by exposure to circularly polarised light are compared with those produced by plane polarised light, and it is concluded that the experiment of Zocher and Coper does not provide a solution of the problem of asymmetrical synthesis. While in this experiment an originally inactive medium has been modified in such a way that its action on polarised light is similar to that of quartz, etc., it does not appear that active molecules have been produced capable of taking part in other reactions and of reproducing other substances acting on polarised light. The necessity for this distinction is shown by a consideration of the effect of the combined action of a magnetic field and a beam of plane polarised light on a thick layer of transparent material carrying the sensitive substance. In this case also an optically active medium is produced having characteristic rotatory powers, but no separation of active molecules is involved. A. J. M.

993. Molecular Scattering of Light in Solid Bodies. Part III. Intensity of Light Scattered by Crystalline Quartz. G. Landsberg and K. Wulfsohn. *Zeits. f. Physik*, 58. 1–2. *pp.* 95–103, 1929.

The intensity of the light scattered by a second quartz crystal was measured as in former tests [see Abstract 318 (1928)] and gave almost the same results. A comparison of the scattered light for quartz and CO_2 when allowance is made for the scattering due to want of homogeneity in the quartz gives a ratio of 2·76. For comparison, CO_2 was chosen since the intensity of the scattered light is approximately of the same order of magnitude. This ratio differs considerably from the value, 6·8, calculated from the Einstein–Smoluchowski formula. The agreement with the Gauss theory is good, this leading to a value of 2·685. A calculation of the Avogadro number gives $N = 6 \cdot 9 \times 10^{23}$. R. S. R.

994. Secondary Diffraction Maxima of Spectral Lines. A. G. Shenstone. *Phys. Rev.* 34. *pp.* 726–729, *Sept.* 1, 1929.

It is shown that the secondary diffraction maxima around a spectral line can be easily photographed under proper conditions. The relative intensities usually do not even approximately agree with Lord Rayleigh's simple theory, indicating that the lenses used in modern spectrographs introduce peculiar forms of aberration. The practical difficulties introduced by the peculiar intensities are discussed. AUTHOR.

995. Optical Diffusion of the Atmosphere. F. Löhle. *Zeits. f. Physik*, 57. 11–12. *pp.* 770–786, 1929.

Visibility is closely connected with the optical diffusion of the atmosphere. This paper describes measurements of diffusion made by determining the brightness of a perfectly black disc (actually an aperture) when viewed from a distance through a measured thickness of the atmosphere. The theory of the relation between this brightness and the diffusion coefficient is treated in the paper, and a description is given of the form of photometer employed for the measurements. The relation between the scattering coefficient and the angle of view is shown graphically.

The results show a marked departure from those obtained on Lord Rayleigh's theory of scattering. [See also next Abstract.] J. W. T. W.

996. Optical Diffusion of the Atmosphere. F. Löhle. *Zeits. f. techn. Physik*, 10. 10. *pp.* 428–434, 1929.

This paper deals with the same subject as that given above [see preceding Abstract], but the instruments used for the measurements are described in detail with diagrams. A theoretical treatment of the problem of deducing the size of the water particles from the scattering coefficient of the mist is given in the present paper. J. W. T. W.

997. Interference Colours of Finely Dispersed Precipitates in Transmitted Light. G. P. Woronkoff and G. I. Pokrowski. *Kolloid Zeits.* 49. *pp.* 1–3, *Sept.*, 1929.

Particularly well-marked colorations are obtained by the condensation of atmospheric water vapour on glass plates cooled to – 15° or – 20° C., but a more lasting effect is produced by precipitates (sublimates) of benzoic acid. An expression is derived for the difference in phase of light passing through the particles and that passing directly through the glass, the calculated results agreeing satisfactorily with those obtained experimentally. In the condensation of water vapour on glass the following colour changes are observable: yellow, orange, red, violet, blue, green, yellow, orange, red—this being in accord with theory. T. H. P.

998. Neutral Wedges with Linear Absorption. G. A. Suckstorff. *Zeits. f. Instrumentenk.* 49. *pp.* 500–504, *Oct.*, 1929.

Photographic wedges are prepared by exposing a plate when placed in contact with a wedge of neutral glass. The accuracy of such wedges is tested by the determination of absorption in the visible region of two known glasses and an accuracy of ± 0·8 unit in the transmission factor is claimed. By stripping the film from the glass, wedges for use down to 2800 Å. are prepared. F. S.

999. Representation of Aberration Diffraction Effects by Means of Rotating Sectors. A. H. Bennett. *Bureau of Standards, J. of Research*, 3. *pp.* 391–398, *Sept.*, 1929.

This paper describes a set of models constructed for the purpose of illustrating the combined effect of spherical aberration and out-of-focus conditions on the axial star image formed by any lens system of circular aperture. Representation of the star discs is accomplished by means of properly shaped rotating sectors. Figures are given showing sectors corresponding to cases in which the spherical aberration varies in amount from $1/8\lambda$ to $1/2\lambda$. The effect of a change of focus in the presence of spherical aberration is illustrated. AUTHOR.

1000. Image Formation by Narrow Pencils of Rays. W. Merté. *Zeits. f. Physik*, 57. 11–12. *pp.* 747–769, 1929.

A continuation of previous work [see Abstract 1164 (1920)] on the equation for the astigmatism and image curvature of an optical system. The application of the theory to different optical instruments is given in the paper. J. W. T. W.

1001. Ronchi's Method of Optical Testing. J. A. Anderson and R. W. Porter. *Mt. Wilson Observat., Contrib. No.* 386. *Astrophys. J.* 70. *pp.* 175–181, *Oct.*, 1929.

Light from a slit is brought to a focus by the lens or mirror to be tested. A short distance in front of (or behind) the focal plane is placed a line-screen having a spacing of 40–200 lines per cm., so oriented that the lines are parallel to the slit image. The shadow lines seen by the eye placed at the focus indicate clearly the characteristics of the wave surface as it leaves the lens or mirror. Instead of a single slit, a line-screen illuminated by a frosted lamp or even by sky light may be used as the source, with the advantage that the illumination is so greatly increased that all observations can be made in a fully illuminated room. Also, for testing concave spherical mirrors, or lenses and paraboloids with parallel light, only one screen is required, one-half of which serves as the source, the other half as the observing screen. In this case the lines of the image are automatically parallel to those of the observing screen. A simple mounting for the screen and light source is described, and results of the examination of a number of lenses and of a slightly defective concave mirror are given; these show that the method is fully as sensitive as the Foucault knife-edge test. AUTHORS.

1002. Prism with an Index of Refraction less than Unity. H. E. Stauss. *J.O.S.A. and R.S.I.* 19. *pp.* 167–174, *Oct.*, 1929.

The general expressions for the deviation, for the relative widths of the refracted and incident beams, and for the relation between errors in the measured quantities and the index of refraction have been derived for radiation in a principal section of a prism whose index of refraction is less than unity. It is shown that the maximum deviation that can be produced by refraction is equal to the deviation at the critical angle of reflection. It results that for angles of incidence near the critical angle of reflection the refracted beam is very broad. With the direction of the light reversed, that is, for large glancing angles of incidence and for values of glancing angles of emergence with the second surface in the region of the critical angle, the refracted beam is very sharp. Diagrams are given to show the relationships in the case of a prism whose index of refraction is $1 - 10^{-5}$. It is pointed out that, assuming ideal conditions, the best experimental arrangement would be one using a right-angled prism with a glancing angle of incidence equal to 90° (angle of incidence equal to zero). AUTHOR.

1003. 36-Inch Reflecting Telescope for Edinburgh Observatory. *Engineering*, 128. *pp.* 288–291, *Sept.* 6; 371–373, *Sept.* 20; 431–434, *Oct.* 4, *and pp.* 488–490, *Oct.* 18, 1929.

This instrument, which is the largest reflector in this country, has been constructed by Sir Howard Grubb, Parsons and Co. It will be mainly employed for spectrographic work but can be adapted for other uses. The instrument is equatorially mounted and the optical system is of the Cassegrain type, the main mirror being 6-in. thick and 37 in. in overall diamater. This mirror is of concave parabolic form with a focal length of 15 ft. and has a 3½-in. hole at the centre. The Cassegrain mirror is of convex hyperbolic form, 10 in. in diameter and designed to give, in conjunction with the main mirror, an equivalent focal length of 54 ft. Numerous photographs and diagrams are reproduced showing the form and disposition of the various parts of the mounting, including the driving clock. The spectrograph made by Adam Hilger, Limited, is enclosed in an outer casing which is electrically heated and forms a constant temperature chamber. Either one, two or three glass prisms or one quartz prism can be used. Three cameras are supplied of 10·6 in., 19·7 in. and 26·6 in.

focus respectively, the short-focus camera being designed to give a flat field of wide angle and having an uncemented triplet lens. A guiding and a viewing telescope are attached to the main support of the spectrograph, and a camera for direct photography is also provided. [See also **R. A. Sampson.** *Observatory*, 52. *pp.* 293–297, *Oct.*, 1929.] F. S.

1004. Zeiss Universal Theodolite. *Engineering*, 128. *pp.* 734–736, *Dec.* 6, 1929.

The instrument described is used for geodetic and tacheometric surveying, has a wide range of application, is compact and is easy to handle. An optical plummet is used for centring over a station point on the ground below or on the roof of a mine road above. Front and rear views of the instrument, and of the optical plummet arranged for upward or downward reading, are given. Three levels are used, a circular box pattern for preliminary adjustment before fixing the instrument proper, and two tubular levels for verticality of the axis and horizontality of the index. The divided circles are glass rings, 3 and 2 in. in diameter for horizontal and vertical circles respectively; they can be read to 1″ and estimated to 0·1″ by an optical micrometer. The eyepieces of telescope and micrometers are close together. The reading mechanism of the horizontal circle is built into the supports of the telescope trunnions, and is illustrated diagrammatically. R. S. R.

1005. Chemical Photometer using Uranyl Oxalate. W. R. G. Atkins and H. H. Poole. *Roy. Dublin Soc., Proc.* 19. 26. *pp.* 321–339, *Sept.*, 1929.

A general historical survey of previous work on the photochemistry of uranyl-oxalate solutions is first given. This is followed by a section dealing with the distribution of light flux reaching a given point in space and its measurement by means of a tube of photosensitive material of given form oriented in any particular way. It is pointed out that the cylindrical tube, placed vertically, measures principally the mean horizontal illumination. If a measurement of the total illumination is desired the material should be exposed in a spherical flask. A tube of uranyl oxalate of specified composition was compared with a potassium photoelectric cell standardised by means of a plain carbon arc. Comparison, presumably under daylight, gave, for 10 cc. of solution in a quartz tube about 13 cm. long by 13 mm. internal diameter, a rate of decomposition of 0·225 cc. per hour for an illumination of 1000 m.-candles. Comparisons of the mean horizontal illumination at sea measured by means of a uranyl-oxalate tube with the vertical illumination measured by the photoelectric cell agreed well, on the average, with the ratios to be expected theoretically when allowance was made for the effect of light reflected off the water. J. W. T. W.

1006. Double Polarisation Photometer. Jobin and Yvon. *Rev. d'Optique*, 8. *pp.* 392–397, *Oct.*, 1929.

Describes the construction of a polarisation photometer by means of which it is possible to measure the absorption and rotary powers of solids or liquids throughout the spectral range 7000 Å. to 2300 Å. A source of light is so arranged that an image is formed by means of an achromatic objective on a slit, after which the narrow beam is divided into two symmetrical portions by a quartz equilateral prism. One of the parts passes through an achromatic objective, is rendered parallel and then reflected at right angles by a quartz prism. It then traverses the absorbing medium, is reflected by a quartz quadrilateral such that it now makes only a small angle with the axis of the instrument, and then passes through a fixed quartz Wollaston prism which is common to both parts of the beam. The two parts then pass through a fluorspar Rothon prism which is mounted on a divided circle, through an objective whose axis is the same as that of the spectrograph slit, and then through two biprisms, falling finally on the slit of the spectrograph. The other part of the beam passes through a similar optical system, going through the solvent instead of the absorbing medium. The spectrograph transforms the two images at the slit into two spectra in juxtaposition, and these can easily be compared photographically. Finally, the theoretical aspects and methods of use of the apparatus for both cases are given. R. C. F.

1007. Graphical Representation of Photometric Magnitudes. M. M. Gurevič. *Phys. Zeits.* 30. *pp.* 640–644, *Oct.* 1, 1929.

The intensity and illumination are considered as vectors, the problems of the simple source, finite source and general field of light being considered in turn. In the first case, it is convenient to introduce a light vector equal to intensity divided by square of distance from the source. For an extended source, the intrinsic brightness is a vector function of position on the source. A general field of light may be specified by the value of F at all points of the field, where F is the light vector, defined in this case as $\int \frac{B\,dS \cos\theta}{r^2}$. Here B is the intrinsic brightness of the element dS of the surface, r the distance of the element from the point at which F is to be evaluated, and the integral is taken over the whole surface. F has the valuable property of being a solenoidal vector. J. H. A.

1008. Relationship between the Resolving Power of Photographic Materials and the Wave-Length of the Illumination. O. Sandvik and G. Silberstein. *Zeits. f. wiss. Phot.* 27. *pp.* 119–127, *Oct.*, 1929.

The connection between resolving power and wave-length of the illumination is given for six different plates, considering the spectral region between λ3800 and λ7250. A similar test object to that used for obtaining the relationship between the resolving power and the test object contrast [see Abstract 585 (1930)] is used, and this is illuminated by means of light from a monochromator after passing through a cylindrical lens. In every case the maximum resolving power is found to be in the violet and near ultra-violet region. For emulsions which are not dye sensitised, the minimum resolving power occurs at the wave-length λ5350, whilst for orthochromatic and panchromatic plates this minimum moves towards the violet, and occurs at a wave-length of λ4850. The relationship is only qualitatively examined, not enough values being given to discuss this theoretically. The phenomena observed are apparently greatly influenced by the absorption and the curving characteristics of the emulsions. [See also Abstract 1734 (1927).] R. C. F.

1009. Supplementary Illumination of Photographic Plates and Photographic Photometry. A. Denissoff. *Zeits. f. wiss. Phot.* 27. *pp.* 128–144, *Oct.*, 1929.

By means of supplementary illumination of photographic plates results are obtained for the variation of the relative blackening and also for the contrast effect of the plates. In the blackening region normally used the supplementary illumination of the same spectral composition as the photographed light produces an increase in the relative blackening. Two different blackening curves are used for the supplementary illumination corresponding to $S = f_1(J)$ for the illumination at the same time as the actual photography, and to $S = f_2(t)$ for supplementary illumination applied either before or after the taking of the photograph. The increase in blackening obtained reaches its maximum at $S = 0{\cdot}05$ for any supplementary illumination, and remains constant up to values of 0·80 with collateral supplementary illumination, and 0·60 for illumination before or after the exposure. This shows that the relative blackening is independent of that due to the fog on the plate. Except for abnormally high values of additional lighting of the plates, the contrast effect remains constant above $S = 0{\cdot}05$. Below this value an increase in contrast effect is obtained. In accordance with the above results the sensitivity of photographic photometry and the accuracy of measurement for low values of the blackening can be increased by the use of supplementary illumination. Further, the effect of any supplementary illumination can be estimated in advance, thus showing whether it would be of use in connection with photographic photometry. R. C. F.

1010. Herschel Effect and Failure of Reciprocity Law. A. P. H. Trivelli and V. C. Hall. *Frank. Inst., J.* 208. *pp.* 483–506, *Oct.*, 1929.

The failure of the reciprocity law has been studied for a pure silver bromide emulsion and a super-speed silver bromo-iodide emulsion. By applying the same infra-red radiation on the latent image formed by the first exposure with three different intensities, different degrees of Herschel effect were obtained. Contrary to the results given by W. Leszynski [see Abstract 981 (1927)], strong Herschel effects were found when very low intensities were used for the first exposure. General statements, therefore, cannot be made at this time. The position of the maximum Herschel effect shifts, in both emulsions investigated, to lower densities as the intensity is decreased in the first exposure. The maximum Herschel effect for every step also shifts towards lower densities as the intensity of the first exposure is lowered. By interpolation we can find the amount of bleaching caused by the infra-red radiation on areas which after development have the same density but which have been exposed to different white-light intensities and afterwards received equal amounts of infra-red light. There is a time effect in the failure of the reciprocity law when infra-red radiation falls on latent images formed by different intensities of white-light exposures. AUTHORS.

1011. Herschel Effect. A. P. H. Trivelli. *Phot. Indust.* 27. *pp.* 1078–1083, *Oct.* 9, *and pp.* 1106–1113, *Oct.* 16, 1929.

After a discussion of the importance of the Herschel effect with regard to the latent image, results are given which extend the quantitative knowledge of this effect. Pure silver bromide emulsions were used as these give a more marked Herschel effect than do silver bromo-iodide emulsions. Curves are given showing the H and D curves for the emulsions used, and the relationship between blackening and development time with blue light only, the H and D curves and the blackening-development time curves for blue light with additional infra-red illumination of 5791 sec. duration, the gradual reduction in density with increase in infra-red illumination, and the influence the gradual increase of infra-red lighting has on the latent image due to the original blue light. All the curves indicating the effect on the density of gradually increasing the infra-red illumination show that for low blue illuminations the infra-red illumination is too strong to give a Herschel effect. As the intensity of the blue light increases the curves converge, finally crossing one another. This is the point at which the Herschel effect begins to appear. With increase of development time this point of intersection moves towards the lower density regions. Finally, three methods of expressing the Herschel effect are given and discussed in the light of these latest results, the maximum effect being obtained between 2·33 and 2·60 blue light densities for a development time of 10 minutes. R. C. F.

1012. Validity of the Einstein Equivalent Law for Sensitised and Non-Sensitised Dry Plates. H. H. Schmidt and F. Pretschner. *Zeits. f. Physik*, 58. 1–2. *pp.* 139–142, 1929.

The results obtained by means of present methods of analysis show that no separation of silver and silver halide can be made which is free from objections. In most cases the figures of the silver value obtained are too high. The same errors occur in the methods used by Eggert and Noddack, and Leszynski [see Abstract 980 (1927)], whilst examining the validity of the equivalent law. Thus it is not possible to say how far the equivalent law is valid for sensitised and non-sensitised dry plates. Finally, the authors refer to a new method of sensitisation. R. C. F.

1013. Sensitisers in Photography. F. E. E. Germann and D. K. Shen. *J. Phys. Chem.* 33. *pp.* 1583–1592, *Oct.*, 1929.

The use of the terms sensitivity and speed is discussed, and the terms sensitisers and desensitisers are suggested for those substances which increase or decrease developability. Similarly the terms accelerators and retarders are suggested for those substances which increase or decrease speed. Trivelli's hypothesis of the latent image is modified in order to correlate the phenomenon of reversal with the mechanism of latent image formation. It is assumed that the sensitive specks consist of silver germs and a molecular complex of the sensitiser which function as an iodine acceptor during exposure. It is the presence of this sensitive complex in the grain that makes the development of the exposed grains possible. The speed of the grains, however, depends on the size of the silver germs which are formed at the time the emulsion is made and cannot be altered by any method of sensitising. The sensitising complex is assumed to undergo a continuous decomposition by the action of light, and thus causes the phenomenon of reversal to take place when the sensitivity material is completely destroyed. E. E. F. d'A.

1014. New Panchromatic Silver Salt Sensitisers and their Significance for the Theory of Hypersensitisation and Sensitisation. A. Steigmann. *Zeits. f. wiss. Phot.* 27. *pp.* 117–118, *Oct.*, 1929.

The new colouring matters are prepared by treating fluoresceins, such as fluorescein and erythrosin, with sodium sulphide, and then with concentrated sulphuric and nitric acids, and reducing the nitrated acid thus formed with sodium hydroxide, sodium hydrosulphite and ammonia; the product, which is crystallised from alcohol, is free from sulphur, and with silver nitrate forms a salt readily soluble in ammonia solution. Without other addition it sensitises only silver chloride and bromide emulsions, and does not influence negative emulsions even in presence of ammonia, but does so if silver chloride or bromide is added. T. H. P.

1015. Growth of Colloidal Silver in Gelatin Layers. H. Arens and J. Eggert. *Zeits. f. Elektrochem.* 35. *pp.* 728–733, *Sept.*, 1929. *Paper read before the Deut. Bunsen Gesell., Berlin, May,* 1929.

Examines the growth of colloidal silver particles which are embedded in the gelatin layers obtained by treating with silver separating solutions, the object being to compare such artificial silver nuclei with those obtained photochemically. Growth curves for layers containing nuclei of the same size but containing differing amounts of nuclei are given. The results of varying the size of the nuclei and subjecting the nuclei to the same growth time, confirm the phenomenon that a definite silver mass which is in a fine state of division shows a stronger catalytic action than if it is coarsely divided. If, however, an equal number per $cm.^2$ of particles of different sizes are considered, the growth in a given time is almost unconnected with particle size. In order to obtain indications for further work on the relations between the characteristics of artificial silver nuclei and those obtained photochemically, two aspects of the problem were examined. Curves are given illustrating a comparison between a nucleus growth curve for particles all of the same size, a blackening curve and a silver mass curve for a physically developed photographic emulsion. The nucleus growth curve has the same characteristic S shape of the other two. Finally, a suitable photographic film is illuminated in the region where the blackening is almost independent of the time of illumination. The curves obtained on examination show that the average nucleus size increases with increasing illumination. A combination of these results with those obtained for various nucleus sizes allows the size of nucleus in this last examination to be determined. R. C. F.

1016. Photochemical Reductions of Silver Salts by Pinachrome. A. Steigmann. *Zeits. f. wiss. Phot.* 27. *pp.* 113–116, *Oct.*, 1929.

Silver nitrate rapidly decolorises aqueous pinachrome solutions, reduced silver being formed. Since the colouring matter is not re-formed by shaking with air, photochemical decomposition and reduction of the pinachrome molecule have apparently occurred. Ammoniacal solutions of silver oxide are also reduced photochemically by pinachrome. When a mixture of methylene blue and pinachrome is used with a negative emulsion, the methylene blue is dominant and strong desensitisation takes place. Since methylene blue sensitises pinachrome in test-tube experiments, it must be assumed that the silver bromo-iodide first decolorises the methylene blue and thus leads to desensitisation. T. H. P.

1017. Amateur Kinematography in Colour: Kodacolor Process. W. Clark. *Phot. J.* 69. *pp.* 402–407; *Disc.*, 408, *Sept.*, 1929.

After a brief description of the development process used by Kodak Limited for their ordinary amateur kinematograph films, the author describes the "Kodacolor" process in more detail than has previously been given [see Abstract 3549 (1929)]. The lenses, actually part of the film, are cylindrical, and extend lengthwise along the film. There are 22 lenses to a millimetre, so that the 16 mm. standard amateur film has 350 of them across its width. Only a Ciné Kodak fitted with a *f*/1·9 lens can be used for the process, and the three-colour filter slips into the front of the lens. In the *Discussion*, **Sunde** remarked on the red halation which was most noticeable when the objects were out of focus. The author stated that this colour fringing was due to a parallax effect, but it was not always red. By putting the projector or camera out of focus the whole image would be fringed. Shrinkage of the film base with age did not apparently affect the colour rendering. With reference to the use of exposure meters, one of the Mayer type—the visual Justophot or Cinéphot—could be used with satisfaction. **B. Cox, F. R. Newens** and **Hibbert** remarked on the lack of crudity in the colours obtained in the projected image by this process. R. C. F.

1018. Monochromatic Excitation of Fluorescence in Benzene at − 183° C. J. Starkiewicz. *Acad. Polonaise Sci. et Lettres, Bull.* 6A, *pp.* 287–294, *June*, 1929.

Light from either a mercury lamp, or from a zinc or cadmium spark, was passed through a monochromator and focussed upon a drop of benzine which was placed on a sheet of brass and partially immersed in liquid air. The fluorescent light was photographed with a quartz spectrograph, and two spectrograms are reproduced. The resulting bands are analysed, and it is concluded that at this temperature the fluorescence is excited by impact and not by intermolecular action. F. S.

1019. Quantistic Theory of Fluorescence. E. Segrè. *Accad. Lincei, Atti*, 9. *pp.* 887–892, *May* 19, 1929.

A mathematical discussion in which the methods of Dirac in a modified form are applied to the phenomena of fluorescence. J. J. S.

1020. New Properties of the Polarised Fluorescence of Liquids. S. I. Wawilow. *Zeits. f. Physik*, 58, 5–6, *pp.* 447–448, 1929.

The calculation of the degree of polarisation given in the author's earlier paper [see Abstract 3319 (1929)] assumes rotation of the molecules about the *y* axis with a constant value for the inclination to this axis. This assumes a special force field. The calculation is given for a more general case and agrees well with experiment. J. E.

1021. Influence of Method of Excitation on Transition Probabilities in Sodium Vapour. C. J. Christensen and G. K. Rollefson. *Phys. Rev.* 34. *pp.* 1157–1166, *Oct.* 15, 1929.

Fluorescence has been excited in sodium vapour at 180° C. by illuminating with the second member of the principal series, $\lambda = 3303$ Å. Both the first and second members of the principal series appeared in the fluorescence, the first member being due to the atom returning to its normal state in steps. The ratio of the intensities of the two lines was determined by photographic photometry and the results compared with what might be expected on the basis of measurements by Weiss on the sodium arc. In the arc the atom returns to the normal state from the 3P by way of the 2S twenty-five times as often as the direct transition occurs, whereas in fluorescence approximately the same number take each path. This is contrary to the usual assumption that the transition probabilities are independent of the method of excitation. AUTHORS.

1022. Uranium as an Activator. Mabel K. Slattery. *J.O.S.A. and R.S.I.* 19. *pp.* 175–186, *Oct.*, 1929.

The experiments were made with a view to confirming the striking relation in the location of the submerged bands found when spectroscopic measurements were made of the fluorescent emission of various dilute solid solutions of uranyl salts. A number of colourless fusible salts were tried in the hope of finding others giving bright resolved spectra similar to that of NaF. The results observed with sodium and lithium fluorides containing dissolved UO_3 are tabulated, and in general it was found that many of the fluorescent preparations seem to have spectra similar to the uranyl salts, differing only in that a shorter wave-length is necessary for excitation. It is found that those fluxes which produce luminescence are those which have marked transparency in the ultra-violet The best fluxes appear to be the fluorides of sodium and lithium, not only in brightness, but in resolution and in the fact that their spectra can be arranged in sets of constant frequency intervals. It is thought that in the case of the solution in fluorides, the uranyl group is definitely broken down and that the emission effects are, therefore, due directly to uranium itself as an activator. J. G. H. B.

1023. Luminescence during Electrolysis. N. Harvey. *J. Phys. Chem.* 33. *pp.* 1456–1459, *Oct.*, 1929.

Luminescence of aminophthalichydrazide in dilute alkali occurs at any anode during the passage of current and at a kathode of Hg, at moist alkaline Al, Zn, Cd, and Sn metal surfaces, and when oxy-gas flames are played on the surface of the alkaline solution. This luminescence is due to active oxygen. Luminescence of hydrazide also occurs in contact with oxidising phosphorus and is connected with ozone formation and decomposition. This hydrazide is suggested as a test for active oxygen. A mixture of oxyluciferin and luciferase may be used as a test for active hydrogen. It is suggested that the term galvano-luminescence be used for luminescences associated with the passage of electric current through liquids. AUTHOR.

1024. Luminescence and Temperature Radiation. P. Pringsheim. *Zeits. f. Physik*, 57. 11–12. *pp.* 739–746, 1929.

In the first part of the paper the apparent contradiction between anti-Stokes fluorescence and the second law of thermodynamics is discussed, and it is shown that this contradiction does not exist in the case of a well-cooled fluorescent gas. The second part describes a lecture demonstration of the difference between luminescence and temperature radiation, which is based upon the modification in light emission by collisions of the second kind in iodine vapour. F. S.

1025. Quantitative Spectroscopic Analysis of Solutions. A. Corsi. *N. Cimento*, 6. *pp.* 275–280, *June*, 1929.

The method used by Occhialini [Abstract 3335 (1929)] to measure the concentrations of the components of an alloy is applied to the determination of the concentration of lead in lead nitrate solution and that of copper in copper sulphate or chloride solution. The results obtained with the two copper salts show that, if the conditions of excitation and the concentration of the element in solution are constant, the length of a line in the spectrum is independent of the nature of the salt in solution. The curves representing the variation in the length of a line with the concentration of the solution, the resistance being constant, are similar for lead and copper; a rapid ascending part corresponds with the lower percentages, the curve afterwards bending to become parallel to the axis of abscissæ at the higher percentages. T. H. P.

1026. Absorption Spectra of Sugars. L. Kwieciński and L. Marchlewski. *Acad. Polonaise Sci. et Lettres, Bull.* 7A. *pp.* 317–330, *July*, 1929. *In English.*

The absorption spectrum of maltose at various times after the addition of hydrochloric acid, that of glucose after addition of NaOH solution, and those of fructose after addition of both, have been determined. The unexpected absorptions noticed in the products of hydrolysis of cane sugar are attributed to decomposition products of lævulose. F. S.

1027. Near Infra-Red Absorption Spectra of Halogen Derivatives of Ethane. B. J. Spence and M. A. Easley. *Phys. Rev.* 34. *pp.* 730–742, *Sept.* 1, 1929.

The infra-red absorption spectra of derivatives of ethane, between $0\cdot 8\,\mu$ and $3\,\mu$ by means of two different spectrometers, one using a grating of 2500 lines per inch and the other using a grating of 10,000 lines per inch. Tables listing spectrometer settings, wave-lengths and wave-numbers are included. A large number of new absorption bands were discovered. It was found that for substances containing no hydrogen no bands existed in the region under investigation. For other substances there was a close similarity in the spectra, particularly where the halogens were interchanged. The bands do not lend themselves to arrangement in a single series, nor does any quantitative relationship exist between the bands in any given substances. No explanation of the mechanism producing the absorption is offered. AUTHORS.

1028. Absorption Spectrum of Nickel Vapour. R. G. Loyarte and A. T. Williams. *Phys. Zeits.* 30. *pp.* 634–640, *Oct.* 1, 1929.

The absorption spectrum of nickel vapour has been measured at 2500° K., using the technique previously developed for tin, manganese and silver. The results are in good agreement with those of Angerer and Joos, McClellan and McLay, and of Majumdar, as well as with those of Narayan and Rao and of Meggers and Walters. The spectrum has been analysed more completely, and in particular the quantum states concerned in certain terms have been determined, where previously only the inner quantum number had been given. With the knowledge gained in this analysis it has been found possible to identify a number of multiplets previously unrecognised. The equation $N'/N = e^{-E/RT}$ has been critically examined, where N′, N are the numbers of excited atoms and the total number of atoms respectively. J. H. A.

1029. Absorption Spectra of Halogen Ions in Aqueous Solution at the Commencement of the Schumann Ultra-Violet Spectrum. G. Scheibe. *Zeits. f. phys. Chem.* 5. *Abt. B.* 5. *pp.* 355–368, *Oct.*, 1929.

The absorption spectra of chlorine, bromine and iodine ions have been measured in aqueous solution at the beginning of the Schumann ultra-violet spectrum and are explained as electronic affinity spectra. After the separation of the electron, the halogen atom can remain either in the stable 2^2P_2 — or in the meta-stable 2^2P_1 — state. Hereby arise two absorption maxima, whose distances apart agree with the values obtained from the known spectra of the atoms. H. H. Ho.

1030. Absorption Spectrum of Nitric Oxide. M. Lambrey. *Comptes Rendus*, 189. *pp.* 574–576, *Oct.* 14, 1929.

A gas enclosed under pressure p in a tube of length l is traversed by a cylindrical beam of monochromatic light, the incident flux being I_0 watt cm.^{2}, the emergent flux I. The optical density of the gaseous stratum is $d = \log I_0/I$, the absorption coefficient $a = d/pl$. In general, a is a constant, to a first approximation. For mitric oxide a increases with p. Measurements have been made on the band $0 \mapsto 0$ of the γ system of NO (λ in the region of 2265 Å.). For all wave-lengths it is found that the apparent optical density is a function of lp^x, where $x = 1{\cdot}81 \pm 0{\cdot}03$. Assuming that the same relation holds for weak values of d, and that the real optical density is proportional to l, then $d = klp^{1{\cdot}81}$. The same exponent is found for all the characteristic points of the absorption curve, and it is, therefore probable that this relation holds for relatively high densities. Hence, the coefficient of absorption is proportional to $p^{0{\cdot}81}$. In the absorption of light by one molecule it is, therefore, necessary to take into account the existence of other molecules. The same law holds for the band $0 \rightarrow 1$ of the γ system of NO, and probably for the general absorption observed outside these bands. Using a constant mass of gas it is found that the effect of temperature, over the range − 80° C. to 300° C., on the optical density varies according to the maxima selected for observation. The band $0 \rightarrow 0$ of the γ system of NO constitutes the resonance band of this molecule, analogous to the radiation 2537 Å. constituting the resonance ray of the mercury atom. The phenomenon of selective diffusion observed in the latter is not observed in the NO band. The values of $k = d/lp^{1{\cdot}81}$ are calculated for various wave-lengths for an apparent optical density of 0·15. A. J. M.

1031. Quantistic Theory of the Raman Effect. E. Amaldi. *Accad. Lincei, Atti*, 9. *pp.* 876–881, *May* 19, 1929.

The methods of Dirac are applied to the theory of the Raman effect. The intensity of the Raman lines is obtained. J. J. S.

1032. Vibrational Selection Principles in the Raman Effect. J. H. van Vleck. *Nat. Acad. Sci., Proc.* 15. *pp.* 754–764, *Sept.*, 1929.

A quantitative and rigorous proof of the usual absence of all Raman displacements except the fundamental $\Delta v = \pm 1$, v denoting the vibrational quantum number, is given. Raman lines for which $\Delta v = \pm 2$ are ordinarily far too weak to be detected experimentally. J. S. G. T.

1033. Raman Effect in Organic Substances. Y. Fujioka. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 204. *pp.* 205–222, *Aug.* 31, 1929. *In English.*

Wood's method of illumination was adopted, the mercury lamp and tube for liquid being placed parallel to one another, each disposed along one focal line of an elliptical cylinder mirror. An electric fan was used to cool the tube, and sometimes a spiral cooling tube was inserted in the liquid tube. Tables of results are given for benzene, toluene, chlorbenzene, brombenzene, phenol, nitrobenzene and anisol, and some spectra are reproduced. The results are discussed and some work on the influence of temperature described. F. S.

1034. Raman Effect in Aqueous Solutions. P. Pringsheim and M. Yost. *Zeits. f. Physik*, 58. 1–2. *pp.* 1–6, 1929.

The Raman spectra of aqueous solutions of H_2SO_4, $(NH_4)_2SO_4$, $Na_2S_2O_3$, $Na_2S_2O_6$, H_2SeO_3, $KHSeO_3$ are described and some conclusions drawn as to the structure of the ions. Ammonium salts in solution give no lines characteristic of the ammonium ion. Uranyl sulphate gives a line belonging to the UO_2-radicle, whose frequency difference agrees with that found from the fluorescence spectrum. F. S.

1035. Raman Effect and the Hydrogen Spectrum. W. Finkelnburg. *Zeits. f. Physik*, 58. 5–6 *pp.* 425–428, 1929.

It is shown that while it is not impossible that some lines in the

spectrum are Raman lines excited by the Balmer lines, it is nevertheless very improbable, and it is contended that it is impossible to attribute 80 molecular lines to this cause as has been done by Allen and Deodhar.
F. S.

1036. Raman Effect in X-Ray Region. W. Kast. *Zeits. f. Physik*, 58. 7–8. *pp*. 519–522, 1929.

The scattering of X-rays in Al corresponds to a loss of energy equal to 1550 volts for K radiation. The Rh K_α line, 612 X.U., should therefore show a shift of 50 X.U. towards longer wave-lengths. With an exposure twenty times that required to record Compton lines, this line has not been observed. The possibility of the excitation of Raman lines in the X-ray region is discussed.
F. S.

1037. Bibliography of 150 Papers on the Raman Effect. A. S. Ganesan. *Indian Journ. Phys.* 4. *pp*. 281–348, *Sept*. 1, 1929.

1038. Relation between Raman Lines and Infra-Red Bands. C. P. Snow. *Phil. Mag.* 8. *pp*. 369–379, *Sept*., 1929.

After a brief discussion of the Langer-Dieke theory of the relation between Raman lines and infra-red bands, it is shown that a scheme similar to that suggested by Dieke for HCl must be used for O_2, N_2 and CO. Further, in all three cases the position of the central Raman line must not coincide with the electronic vibration frequency. The existence of infra-red absorption bands for gaseous oxygen and nitrogen, although by no means definite, is from experimental evidence to be considered, and further work by the author leads to the view that absorption by oxygen is highly probable. A metre path of oxygen has 5 % as its upper limit of the intensity of absorption. The agreement of the Langer-Dieke account with the Raman effect is fully stressed, whilst some peculiar numerical relationships derived by Bailey are discussed, as their acceptance would imply a more involved explanation of the Raman effect. Hydrogen provides the most important obstacle for the Langer-Dieke theory to surmount, the results of the Raman effect for H_2 not yet having been explained by the theory.
R. C. F.

1039. Polarisation of Raman Lines. A. C. Menzies. *Phil. Mag.* 8. *pp*. 504–515, *Oct*., 1929.

Using a small source and a double-image prism, observations have been made of the light scattered by carbon tetrachloride and other liquids at 90° and at an angle of about 160°. It is suggested that the observed polarisation of the line can be explained if it is supposed that the direction of the initial vibration is parallel to that of the final vibration in the case of the plane-polarised lines, and that they are perpendicular to one another in the case of the unpolarised lines. Lines partially polarised can be explained by the inclination of the directions of vibration to one another being intermediate between the two cases. The Raman spectrum of quartz has been measured for three different orientations of the optic axis, and the state of polarisation of the lines has been investigated. Some of the scattered lines change their direction of polarisation through 90° as the direction of the optic axis is similarly turned. Two lines remain plane-polarised in the customary direction (parallel to that of the unmodified lines) in spite of the orientation of the optic axis being changed, and in the case of two other lines the direction of polarisation is invariable also, but is perpendicular to the usual direction (vibration parallel to the direction of propagation of the incident light). An energy-level diagram is given which co-ordinates the Raman and infra-red observations, and may have some real significance. [See Abstracts 1858 (1929) and 655 (1930).] AUTHOR.

1040. Raman Effect from Powdered Crystals. A. C. Menzies. *Nature*, 124. *pp.* 511–512, *Oct.* 5, 1929.

Observations of the Raman effect made upon solids have so far had to be restricted to solids which can be obtained in the form of large clear specimens. It is found that Raman lines can be photographed by using the solid in the form of a coarse powder in a flask, and observing the scattering at right angles in the usual way. The incident light is then so weakened by repeated reflections that the modified lines can be observed, in spite of their relative great weakness. In the case of potassium nitrate, the line corresponding to a shift 9·52 μ is very strong, and this is taken to be the optically inactive fundamental frequency of the NO_3 ion. A. C. M.

1041. Raman Spectrum and Geometrical Isomerism: Raman Spectrum of the Two Forms of Dichloroethylene. G. B. Bonino and L. Brüll. *Zeits. f. Physik*, 58. 3–4. *pp.* 194–199, 1929.

The Raman spectra of cis- (b. pt. 60·25°) and trans- (b. pt. 48·35°) dichloroethylenes have been studied, excitation being effected by light from the mercury arc. The corresponding ultra-red spectra of the two geometrical isomerides are not identical. The band of the C–H linking occurs in both cases at 3·25 μ, and the bands at 6·30 and 7·25 μ are also common, but the cis-modification lacks two lines, corresponding with 7·85 and 13·12 μ, which appear with the trans-isomeride. Beyond 15 μ the infra-red spectrum disclosed by the Raman spectrum shows fundamental and irreducible differences in the two forms. With the trans-compound there appears only one band at 41·1 μ, whilst with the cis-form three distinct bands at 17·60, 24·50 and 58·5 μ are observed. Hence the effect of the geometrical isomerism in this very simple case produces pronounced differences in the Raman spectra, and presumably also in the infra-red absorption spectra. As regards the intensity of the absorption, consideration of the Raman spectrum gives only qualitative indications. An attempt is now being made to measure directly the absorption coefficients of the band of the C–H linking at 3·25 μ in the infra-red spectrum for both isomerides, and hence to decide if the different orientations of the groups in the molecule, or the electric moment, may have an influence on the probability that the C–H linking takes part in the absorption.

T. H. P.

1042. Intensity Measurements in the Raman Effect and the Distribution Law of Maxwell-Boltzmann. L. S. Ornstein and J. Rekveld. *Phys. Rev.* 34. *pp.* 720–725, *Sept.* 1, 1929. *Zeits. f. Physik*, 57. 7–8. *pp.* 539–544, 1929.

By a consideration analogous to that which Einstein used in his treatment of Planck's law it is shown that for the ratio of intensities between Stokes and anti-Stokes lines in the Raman effect the following formula holds: $\frac{I_S}{I_{AS}} = \frac{\nu - \nu_i}{\nu + \nu_i} e^{h\nu_i/kT}$. Intensity measurements on carbon tetrachloride have been made, and a good agreement with the theory is found. It is shown that it is possible to develop this method into a precision measurement of the constant *h/k*. AUTHORS.

1043. First Spark Spectra of Zinc and Cadmium. Y. Takahashi. *Ann. d. Physik*, 3. 1. *pp.* 27–48, *Oct.* 2, 1929.

The spectra of ZnII and CdII in the negative glow of a helium discharge have been investigated with quartz and vacuum grating spectrographs. The values are analysed in comparison with those of CuI and HgII, and tables of wave-lengths, term values and combinations are given. A higher member of the series is strengthened in the case of CdII, due to the excitation of metal atoms by helium ions. F. S.

1044. Spark Spectrum of Thallium, Tl II.—Term Analysis. Fine Structure of Lines. J. C. McLennan, A. B. McLay and M. F. Crawford. *Roy. Soc., Proc.* 125. *pp.* 570–578, *Oct.* 1, 1929.

Spectra of the spark in air between thallium electrodes were photographed from λ8500 to λ1850, and spectra of a condensed oscillatory discharge between aluminium terminals in an evacuated quartz tube containing heated thallium vapour were photographed from λ7000 to λ2100. While the lines in the former were broad and diffuse, those in the latter were sharp and readily measured. Fine structure was observed in many of the lines, especially with the discharge tube as a source, the magnitudes of the line separations in many cases being much greater than any previously reported in an atomic spectrum. The evaluated energy levels of Thallium II with their designations, the n^* values [see Abstracts 1559 and 1560 (1929)] of representative $6snx$ terms, and the triplet term intervals are recorded, together with the classified wave-lengths, observed fine-structure components and their intensities, and the intensity sum for each term combination. The ionisation potential, $6s^2\,{}^1S - 6s\,{}^2S$ was estimated to be approximately 165,700 cm.$^{-1}$ or 20·5 volts for Tl II. Some fine structure patterns of Tl II are interpreted on the basis (with which the observations are consistent) that the Back–Goudsmit vector equation $F = J + I$ is valid, that the selection rule $\Delta F = \pm 1$ or 0 holds and that $I = \frac{1}{2}$. These patterns are given in multiplet form, and from them fine structure intervals are determined. A. J. M.

1045. Variations in the Spectrum of the Light Emitted by Quartz Mercury Lamps. T. Takahashi and L. H. Clark. *Journ. Sci. Instruments*, 6. *pp.* 273–277, *Sept.*, 1929.

The spectra of the radiation emitted by mercury lamps in common use have been studied. Variations in the distribution of intensity in the spectra have been observed and traced to irregularities in the quartz envelopes of the lamps. A mercury lamp provided with a plane quartz window has been made which removes this defect and is advocated for spectroscopic measurements. AUTHORS.

1046. Quartet Structure of the First Spark Spectrum of Mercury, HgII. S. M. Naudé. *Ann. d. Physik*, 3. 1. *pp.* 1–26, *Oct.* 2, 1929. *Paper read before the British Assoc., S. Africa, Sept.*, 1929.

The conditions for exciting a discharge in pure mercury vapour were found, and it appeared that the unarranged lines were considerably strengthened. The spectrum from 8000 Å. to 890 Å. was photographed with glass and quartz spectrographs, and also with a vacuum grating instrument. Comparison of the results with those of helium led to the finding of a number of multiplets belonging to the quartet system. The analogous spectrum of copper confirmed the arrangement. Tables are given of term values and of observed wave-lengths. F. S.

1047. Efficiency of Quenching Collisions and the Radius of the Excited Mercury Atom. E. Gaviola. *Phys. Rev.* 34. *pp.* 1049–1051, *Oct.* 1, 1929.

It is shown that the interpretation given to the reabsorption-factor *f* in the previous publication was erroneous [see Abstract 2485 (1929)]. An improved and general treatment of reabsorption is given in which the radius of the excited mercury atom turns out to be 3·4 Å. for hydrogen and 5·7 Å. for CO collisions. The efficiencies of collisions with other gases are 0·4 for H_2O, 0·2 for N_2, 0·05 for A, and 0·005 for He. AUTHOR.

1048. Spectrum of the Neutral Mercury Atom in the Wave-Length Range from 1 to 2 μ. E. D. McAlister. *Phys. Rev.* 34. *pp.* 1142–1147, *Oct.* 15, 1929.

New information on the near infra-red spectrum of mercury has been obtained with a specially constructed thermocouple in connection with an automatic recording spectrograph. Fourteen new lines predicted by the combination principle, and eight unclassified lines have been found in this region. Intensity relations for the triplet $1^3S_1 - 2^3P_{0,\,1,\,2}$, which extends over 2700 Å., have been found to follow rather closely the summation rule as defined by R. H. Fowler for wide multiplets. AUTHOR.

1049. Spark Spectra of Germanium. R. J. Lang. *Phys. Rev.* 34. *pp.* 697–711, *Sept.* 1, 1929.

The first three spark spectra of germanium have been extended by the discovery of many new terms and combinations. These are given. [See also Abstracts 1293 and 3034 (1928).] AUTHOR.

1050. Spectrum of Gallium II and the ($4s4p^2$) Configuration in Gallium I and Indium I. R. A. Sawyer and R. J. Lang. *Phys. Rev.* 34. *pp.* 712–719, *Sept.* 1, 1929.

The spectrum of gallium has been excited in a hollow kathode discharge in helium and photographed in the region from λ10,000–λ200. About 90 lines so excited have been classified in singlet and triplet series of GaII. Peculiarities in the run of the intensities in successive members of the series have been found due to the excitation by helium which is sufficient to excite only terms greater than 12,000 ν-units in this spectrum. Absolute term values are calculated, and the lowest term is $(4s^2)^1S = 165458$ corresponding to an ionisation potential for GaII of 20·43 volts. Tables of classified lines and of term values are given. The lines arising from combinations of $(4p^2)^4P$ and $(4p^2)^2S$ with $(4s4p)^2P$ of GaI have been identified, and values of these terms are given. Preliminary work on the excitation of the indium spectrum in helium has enabled the location of $(4p^2)^4P$ in InI, and its term values and combinations with $(4s4p)^2P$ are given. AUTHORS.

1051. Arc Spectrum of Nickel (NiI). H. N. Russell. *Phys. Rev.* 34. *pp.* 821–857, *Sept.* 15, 1929.

Almost all the known lines (1071) of NiI have been classified. There are included in the classification 66 lines from the solar spectrum which have not been found in the laboratory. The spectrum, in spite of its apparent complexity, is admirably regular. Every observed term fits without constraint into the scheme predicted by Hund's theory. A few of the predicted terms have not been found, but in all cases their combinations should either be faint or out of range. Term values, combinations, configurations and identified lines are tabulated. The principal ionisation potential of the neutral Ni atom is calculated to be 7·606 volts. It corresponds to a double electron change from the configuration d^8s^2 to d^9.

AUTHOR.

1052. Extension of Spark Spectrum of Copper, CuII. G. Kruger. *Phys. Rev.* 34. *pp.* 1122–1131, *Oct.* 15, 1929.

The ground term of CuII is a $3d^{10}\ {}^1S_0$. The next higher terms are $3d^9\,4s\ {}^1D\ {}^3D$, and still higher are found the terms $3d^9 4p\ {}^1(P^\circ D^\circ F^\circ)\ {}^3(P^\circ D^\circ F^\circ)$. These facts were already known from the work of other investigators. With a Schüler lamp of the hollow kathode type as a source, the spectrum of copper was photographed by means of a vacuum spectrograph which was so designed that the region 0 Å.–2600 Å. could be photographed on one plate. Two higher members of the $3d^9ns\ {}^1D\ {}^3D$ series have been found, thus giving in all four members of both series, from which the limits of the series have been calculated. The calculations show that the $3d^{10}\ {}^1S_0$ level lies 163,634·2 cm.$^{-1}$ below the $3d^9\ {}^2D_{5/2}$ of CuIII, from which the ionisation potential of CuII is computed to be 20·2 volts. This places the first members of the $3d^9ns\ {}^3D_{3,2,1}$ series at 141,709·2 cm.$^{-1}$, 140,790·7 cm.$^{-1}$ and 139,639·5 cm.$^{-1}$ respectively. Higher members of the $3d^9np\ {}^1(P^\circ D^\circ F^\circ)$ ${}^3(P^\circ D^\circ F^\circ)$ series have also been identified, thus making it possible to confirm Hund's predictions [see Abstract 2493 (1929)] concerning the limits which the various series members approach. AUTHOR.

1053. Second Spark Spectrum of Selenium. A. S. Rao. *Zeits. f. Physik*, 58. 3–4. *pp.* 251–254, 1929.

The term arrangement of the SeIII spectrum has been sought on analogy with those of GeI and AsII, and the most prominent lines recorded by L. and E. Bloch have been found to belong to SeIII. A table of classified lines is given, and likewise tables of electron arrangement and term structure. F. S.

1054. Electric Furnace Spectrum of Hafnium. A. S. King. *Mt. Wilson Observat., Contrib. No.* 384. *Astrophys. J.* 70. *pp.* 105–113, *Sept.*, 1929.

The spectrum of metallic hafnium has been examined from λ2640 to λ6500 in the carbon-tube furnace and compared with the spectra of the arc and spark. A list of 338 lines includes the stronger neutral and ionised lines in this range. The usual temperature classification is given for the lines of the neutral spectrum, based on their relative intensities at 2900° and 2600° C. The lines which, judged by their relative intensities in arc and spark, belong to the ionised atom are absent from the furnace spectrum. The ionised lines are selected on the basis of their behaviour in the three sources. Attention is called to a band spectrum appearing in the arc in air and presumably due to the oxide. Wave-lengths are given for the first head in each of nine groups between λ3200 and λ 5700. [See also Abstracts 172 and 173 (1929).] AUTHOR.

1055. Absorption of Hα Line. T. Takamine and T. Suga. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 202, *pp.* 193–197, *Aug.* 25, 1929. *In English.*

Both emission and absorption tubes were of pyrex glass, the former being filled at about 50-cm. pressure and the latter at a few cm. only. The tubes were connected in series and excited by an 80-cm. spark coil. The line was photographed with a plane grating spectrograph, both the photograph and microphotometer record being reproduced. It was found that the absorption tube must be in Wood's "black" stage [see Abstract 1600 (1920)]. F. S.

1056. Continuous Hydrogen Spectrum in the Ultra-Violet. D. Chalonge and M. Lambrey. *Rev. d'Optique*, 8. *pp.* 332–348, *Sept.*, 1929.

Two tubes of the end-on type with quartz window are described. The one has internal electrodes and is operated by a transformer, while the other has external electrodes and is excited by a high-frequency generator. The pressure of hydrogen is 3 mm. The influence of gas pressure, conditions of discharge, etc., have been studied, and it is claimed that the source is suitable for photometric work. Some records of the absorption spectrum of oxygen in the Schumann region are reproduced. F. S.

1057. Spectrum of H_2: Bands Analogous to the Orthohelium Line Spectrum. Part II. O. W. Richardson and K. Das. *Roy. Soc., Proc.* 125. *pp.* 309–330, *Sept.* 2, 1929.

Discusses the band spectrum of hydrogen in the light of very recent data. The classification previously given [see Abstract 2185 (1929)] requires modification, and in particular it is now likely that the system originally treated as $3^3S \rightarrow 2^3S$ has really an initial principal quantum number of 2. All the known systems which end on 2^3S are discussed, but there is the possibility that still others exist with this final state. The moment of inertia in the vibrationless state is now calculated as $10 \cdot 42 \times 10^{-41}$ gm. cm.^{2} and the internuclear distance as $1 \cdot 119 \times 10^{-8}$ cm. J. H. A.

1058. Influence of Argon and of Hydrogen on the Spectra of Zinc Vapour. J. G. Black, W. G. Nash and C. A. Poole. *Phys. Rev.* 34. *pp.* 1138–1141, *Oct.* 15, 1929.

An experiment to determine the influence of argon and hydrogen gases on the spectrum of zinc vapour is described. Low-voltage arcs were struck in zinc, zinc-hydrogen, and zinc-argon mixtures under controllable conditions and the resulting spectra showed marked changes in the intensities of certain lines. The following lines were markedly quenched by both A and H_2: λλ6479, 6214, 5894, 5772, 5182, 4924, 4911, 4298, 4292, 4113, 3965, 2801, 2770. The following lines, λλ6362, 4810, 4722 and 4680 showed a small decrease in intensity, but the quenching action on them was very small compared with that on other lines. The resonance line at 3075 Å., which is very intense in the pure zinc spectrum, is also very strong in the zinc-argon mixture. There is absolutely no trace of this line, however, in the zinc-hydrogen mixture. A special discussion of the lines λλ4629, 3345, 3302 and 3282 is given. A simple explanation of the intensity changes in terms of the critical potentials of the two gases cannot be made except in the case of the λ3075·8 line, since it is found that the monatomic, inert gas argon, with relatively high critical potentials produces the same type of quenching as molecular hydrogen, with this exception. AUTHORS.

1059. Spectrum of the Negative Glow in Oxygen. K. G. Emeléus and Florence M. Emeléus. *Phil. Mag.* 8. *pp.* 383–392, *Sept.*, 1929.

A partial photometric study of the negative glow has already been made by Seeliger and Lindow. In the present paper the authors describe a more complete examination of the negative glow spectrum below λ8000. Using a discharge tube similar to that described by Paschen, no lines were found below λ2882 except on immediately setting up the tube, these disappearing after running with repeated renewals of gas. The spectra present in the negative glow are the visible and ultra-violet negative bands of oxygen, the violet ozone bands, strongest nickel lines between λ4000 and λ2900, two lines of NiII, three lines of OIII, all the strong lines of OI, and the OII spectrum. No trace could be found of prominent lines of OIV. Using the spectroscopic data obtained, together with the properties of the oxygen atom and molecule, an examination of the extent to which the production of the negative glow spectrum can be explained in the light of recent work upon the electrical conditions obtaining there is given. Finally, it is suggested that owing to similarity between the properties of the equipotential negative glow and those of ionised stellar atmospheres, this may prove fruitful in future developments of the theory of the negative glow. R. C. F.

1060. Structure of the Band Spectrum of Helium. W. E. Curtis and A. Harvey. *Roy. Soc., Proc.* 125. *pp.* 484–506, *Oct.* 1, 1929.

Comparison of the obtainable He_2 rotation term differences shows that in each electronic sequence they tend to a set of limiting values which are the same in all cases and must be those characteristic of the He_2^+ ion. These limiting values are identical for the ortho- and para-systems of bands, and the molecular constants of He_2^+ are calculated from them. A classification of the term sequences is given which agrees with that of Dieke. Eight new bands are described, four of which involve a type of level predicted by Hund but not previously recognised; thus the theoretical term scheme is completed for ortho-He_2. New interpretations are proposed for several bands recorded by other workers. [See also Abstract 812 (1929).] J. J. S.

1061. Light Excitation in the Negative Glow of a Helium Discharge. Y. Takahashi. *Ann. d. Physik*, 3. 1. *pp.* 49–57, *Oct.* 2, 1929.

The different possibilities of the various modes of excitation of foreign atoms in the negative glow layer of helium inside a cylindrical kathode are discussed. The phenomenon of anomalous intensities in the series of CdII was the cause of the investigation, and the author discusses why in this case such anomalies occur, but not so clearly in the case of ZnII and HgII. The possibilities of excitation are the metastable states 2^3S and 2^1S of the helium atom, and the helium ion, besides the electrons. It is shown that the results obtained are to be expected according to theory. H. N. A.

1062. Dissociation of Nitrogen by Electron Impact. L. A. Turner and E. W. Samson. *Phys. Rev.* 34. *pp.* 743–746, *Sept.* 1, 1929.

The $2p^23s\ ^4P - 2p^23p\ ^4P^\circ$ NI lines near 8200 Å.U. are produced by bombarding N_2 molecules with electrons having energies of 23 ± 1 volts or more. Experiments with different currents and pressures indicate that the rate of production of excited atoms depends on a single impact and not upon successive double impacts. A discussion is given of the possibility that the lines are emitted following the recombination with electrons of N^+ ions, shown by positive ray experiments to be produced at this voltage. [See also next Abstract.] AUTHORS.

1063. Excitation Potential of the Negative Bands of Nitrogen. L. A. Turner and E. W. Samson. *Phys. Rev.* 34. *pp.* 747–751, *Sept.* 1, 1929.

The energy of excitation of the 0 → 1 negative band of nitrogen at 4278·1 Å. is found to be 19·0 volts, by comparison with the energy of excitation of neon lines. This gives a value of 15·8 volts for the ionising potential of nitrogen, and of 8·4 volts for the heat of dissociation. Peculiar effects in the excitation of the $2s - 2p$ lines of neon are discussed. [See also previous Abstract.] AUTHORS.

1064. Rotational Structure of the Blue-Green Lithium Band. K. Wurm. *Zeits. f. Physik,* 58. 7–8. *pp.* 562–569, 1929.

The blue-green absorption band in the lithium (molecular) spectrum has been examined with a large plane grating giving 1·38 Å. per mm. dispersion in the first order. The P, Q and R branches were identified, and the absolute values of the j quantum number assigned. The moment of inertia of the molecule and separation of the nuclei have been calculated from the results. J. H. A.

1065. Excitation of MgII Spectrum by Impacts of the Second Kind with Metastable Atoms and Ions of Rare Gases. O. S. Duffendack, C. L. Henshaw and Marie Goyer. *Phys. Rev.* 34. *pp.* 1132–1137, *Oct.* 15, 1929

The MgII spectrum was excited in normal low-voltage arcs in mixtures of magnesium vapour with hydrogen, argon, neon and helium respectively in a tungsten furnace apparatus. The densities of the spectral lines were measured with a Moll microphotometer. The excitation is believed to be due to impacts of the second kind between normal magnesium atoms and metastable atoms or ions of the gas used. It is shown that a small amount of kinetic energy may be added to the inner energy available in the impacts of the second kind and that a larger amount of excess inner energy may be transformed into kinetic energy in such an impact. The probability of an impact of the second kind decreases after the excess energy reaches a certain value. AUTHORS.

1066. Infra-Red Investigations of Molecular Structure. Part III. The Molecule of Carbon Monoxide. C. P. Snow and E. K. Rideal. *Roy. Soc., Proc.* 125. *pp.* 462–483, *Oct.* 1, 1929.

The vibration-rotation band ($n'' = \frac{1}{2} \rightarrow n' = \frac{3}{2}$) of CO has been resolved completely. Its centre is at $2144 \pm 0 \cdot 4$ cm.$^{-1}$, it has no Q branch, and the separations of lines converge on the side of higher frequency and diverge on the lower side. The general character of vibration-rotation bands carried by ^2S molecules is discussed and the CO bands are shown to be consistent with the scheme. The molecular constants deduced from the vibration-rotation bands are compared with those from the electronic bands. From the positions of the band lines the constants of potential functions have been determined. A graphical representation is given of the potential function of the molecule. As to alternating intensities, it is suggested that the only vibration-rotation bands showing this effect are those of the symmetrical molecules of acetylene and ethylene. The detailed character of the bands agrees so well with the theory of the ^2S diatomic molecule as to make it theoretically possible completely to describe the vibration-rotation bands of this type of molecule. [See also Abstract 3076 (1929).] J. J. S.

1067. Experimental Study of Certain Electronic Bands of CO_2. J. F. Duncan. *Phys. Rev.* 34. *pp.* 1148–1153, *Oct.* 15, 1929.

The electronic bands of CO_2 lying near 2880 Å. and 2895 Å. are described and a method given for photographing them under very high dispersion. Three good plates were obtained which gave concordant results when examined with a comparator and with a Moll microphotometer. The fine structure, the probable emitter of the bands, and their relation to other bands of the spectrum are discussed. [See also Abstract 2516 (1927).] AUTHOR.

1068. Relative Intensities in Nuclear Spin Multiplets. E. L. Hill. *Nat. Acad. Sci., Proc.* 15. *pp.* 779–784, *Oct.*, 1929.

The discovery and resolution of an extremely fine structure in some of the spectral lines of atomic Bi, Cs and Tl have suggested that the nucleus of an atom is possessed of a spin moment which can interact with the outer electrons. The analysis in the case of a single electron in the Coulomb field of a nucleus of spin moment $(h/2\pi)/2$ has been given by Hargreaves [see Abstract 202 (1930)]. The method involves the use of a number of simultaneous wave functions and the computational difficulties are prohibitive even in the case of a single electron. The author shows how, by using known expressions for the coordinate matrices, it is possible to derive intensity formulæ applicable in the general case, provided suitable assumptions are made regarding the type of quantisation introduced by the nuclear spin. J. S. G. T.

1069. Fine Structure of Spectral Lines. J. C. McLennan and E. J. Allin. *Phil. Mag.* 8. *pp.* 515–520, *Oct.*, 1929. *Roy. Soc. Canada, Trans.* 23. *pp.* 7–11, *Jan.*, 1929.

The spectra of various elements show certain complex lines which from the ordinary scheme of atomic levels determined by three quantum numbers should be simple. The authors are concerned with the origin of this hyperfine structure, in particular whether it is due to the extra-nuclear electrons or to the nucleus itself. In the former case the arc spectrum of any element would be expected to exhibit the same hyperfine structure as the corresponding lines in the first spark spectrum of the element next below it in the periodic table which has an identical extra-nuclear electron configuration. New measurements on the hyperfine structure for lines in the visible region are presented for the following: PbII, ZnII, CdII, BaI, LaII. Comparison of these results, together with other data, indicates no similarity between the hyperfine structures of corresponding lines of the neutral atom and of the ionised atom next below in the periodic table. The following table gives an example of the comparisons made:

${}^2P_2 - {}^2D_3$	Single in ZnII	Single in CuI
${}^2P_1 - {}^2D_3$	Double in CdII	Single in AgI
${}^3D_1^0 - {}^3D_2$	Quartet in LaII	Single in BaI
${}^3D_1^0 - {}^3D_1$	Single in LaII	Double in BaI

W. S. S.

1070. Ionisation in the Stark Effect. J. Kudar. *Zeits. f. Physik,* 57. 9–10. *pp.* 705–709, 1929.

Revises the quantum theory of the Stark effect. The hydrogen atom in the electric field is only capable of a finite number of discrete conditions, each of them involving a probability of ionisation. The usual treatment of the problem does not consider this. The author sketches a method of introducing the probability of ionisation depending upon the field strength. E. E. F. d'A.

1071. Possible Interpretation of the Electromagnetic Field of Light. F. J. v. Wiśniewski. *Zeits. f. Physik*, 56. 9–10. *pp*. 713–716, 1929.

The author attempts an interpretation of light which forms a bridge between the wave theory and quantum theory of light. He assumes that every light quantum has an electrical moment. Further, the direction and intensity of the electric field of a light wave indicate the direction and measure the intensity of the mechanical force with which the totality of the electric moments of the quanta act upon an electric unit charge at rest. Lastly, the direction of the resultant electrical moment of a totality of light quanta is identical with the direction of the electrical field of light. On these assumptions it is possible to translate the known qualities of light, such as polarisation and interference, into the language of quanta.
E. E. F. d'A.

1072. Effect of a Transverse Magnetic Field on the Propagation of Light *in Vacuo*. W. H. Watson. *Roy. Soc., Proc.* 125. *pp*. 345–351, *Sept*. 2, 1929.

The aim of the experiments was to detect a possible magnetic moment of a photon. Light was passed through a Fabry-Perot étalon placed in a strong magnetic field H directed perpendicular to the path of the light. A change of frequency equal to $\Delta\nu = \pm \mu H/h$ would correspond to a positive effect similar to that of a particle of moment μ, and would be detected by the change in the interference pattern formed by the interferometer. No effect was found, so that the magnetic moment, if it exists, is less than $1{\cdot}4 . 10^{-22}$ e.m.u. (magnetic moment of a proton $= 5{\cdot}10^{-24}$ e.m.u.). W. S. S.

1073. Modification of Glocker's Method of Quantitative Analysis by Means of X-Ray Absorption. N. H. Moxnes. *Zeits. f. phys. Chem*. 144. *Abt. A*. 1–2. *pp*. 134–136, 1929.

The method devised by Glocker [see Abstract 1418 (1925)] for quantitative analysis by means of X-ray absorption consisted in observing the absorption of the "continuous" X-ray spectrum in the material to be analysed. The author has modified the method by employing the absorption by a given element of lines lying on opposite sides of its absorption limit. An example is given in which the tungsten L spectrum was employed, $WL\beta_4$ and $WL\beta_3$ lying on opposite sides of the limit for Zn. The amount of ZnO_2 in a mixture of ZnO and Al_2O_3 (about 1–3 % ZnO) was then accurately determined. W. V. M.

1074. Ionisation of the Halogens by X-Rays. O. Gaertner. *Ann. d. Physik*, 3. 3. *pp*. 325–332, *Oct*. 30, 1929.

Continuing the investigation of the relation between ionisation and absorbed energy [see Abstract 205 (1930)], the case of the halogens (excepting fluorine) and their methyl compounds is dealt with in this paper. In the measurements of ionisation using a filtered copper radiation of 1·38 Å. mean wave-length the following values in volts per pair of ions were found: chlorine, 23·6; bromine, 27·9; iodine, 28·8; methyl chloride, 26·0; methyl bromide, 28·7; methyl iodide, 29·8. J. J. S.

1075. Spinning Target X-Ray Generator and Its Input Limit. A. Müller. *Roy. Soc., Proc.* 125. *pp.* 507–516, *Oct.* 1, 1929.

It is desirable in many investigations that the amount of energy emitted in a second from the unit area of the focus of an X-ray generator should be increased. The limit is normally imposed by the intense heating of the focus. The matter was previously discussed by the author [see Abstract 661 (1928)], and the present paper is a theoretical discussion of the extent to which the specific input can be raised when the focus is produced on a moving target. W. V. M.

1076. Reflection of X-Rays from Crystals of Aluminium. R. W. James, G. W. Brindley and R. G. Wood. *Roy. Soc., Proc.* 125. *pp.* 401–419, *Oct.* 1, 1929.

The observed variations with temperature of the intensity of reflection of X-rays from crystals of rock-salt and sylvine agree with those predicted by the theory of Debye as modified by Waller. The absolute intensities of reflection also agree closely with those calculated theoretically. In the present paper an account is given of the extension of the investigations to a metallic element—aluminium. The temperature-factor deduced from the results was found to agree well with the Debye–Waller theory. The intensity of reflection of X-rays by single crystals of Al was studied at ordinary temperatures and at the temperature of liquid air. From the temperature-factor an estimate of the amplitude of the heat motions of the atoms in the aluminium lattice is obtained. Absolute values of the atomic scattering power, F, for the Al atom were obtained, and were found to agree closely with the theoretical F curves for the atom at rest, obtained from the Schrödinger charge-distribution for Al calculated by Hartree's method, assuming the existence of zero-point energy. Curves showing the contributions of the different electron groups to the F curves indicate that at all angles of scattering at which spectra can be obtained from the Al crystal the values of F for the different possible states of ionisation of the Al atom differ by less than the experimental errors in the determination of F. J. J. S.

1077. Reflection of Kα Line of Carbon from Glass. E. Dershem. *Phys. Rev.* 34. *pp.* 1015–1020, *Oct.* 1, 1929.

A vacuum spectrograph was constructed in which a beam of monochromatic radiation in the extremely soft X-ray region could be isolated by means of a ruled grating and then reflected from a mirror. This mirror could be rotated and the intensities of the reflected rays corresponding to various glancing angles of incidence could be compared by a photographic method. Using a glass surface and the Kα line of carbon (wave-length = 44·6 Å.), measurements of reflected intensity were made for glancing angles of incidence between 1° and 8°. At 8° the reflected intensity was found to be less than 4 % of the intensity at 1°. However, the curve relating intensity of reflection with glancing angle of incidence shows no abrupt change of slope, such as would occur in the case of hard X-rays. This indicates that absorption effects modify the intensity of the reflected ray sufficiently to obscure any sudden change at the critical angle in the case of the reflection from glass of wave-lengths as long as or longer than 44·6 Å. AUTHOR.

1078. Reflection of X-Rays from Platinum Films Sputtered on Glass. H. E. Stauss. *Phys. Rev.* 34. *pp.* 1021–1025, *Oct.* 1, 1929.

The reflection of X-rays from films of platinum of varying thicknesses sputtered on glass was studied to determine whether there is a variation of the critical angle of reflection with the thickness of the film, such as is observed in the case of nickel. Although some difficulty was met in determining the critical angles, the results indicate that there is a similar variation of the maximum angle of reflection. The critical angles of several silver films, sputtered under as nearly identical conditions as possible, were found to differ by amounts much greater than can be attributed to experimental errors. No effort was made to determine whether there is a variation with thickness. In the cases of a number of films strong scattered radiation having deviations as great as 1° 46′ with the primary beam was observed. The reflected beam proper formed the lower limit of the scattered beam. As heterogeneous radiation was being used, it could not be determined whether the reflected wave-lengths were also being scattered. [See also Abstract 1925 (1928).] AUTHOR.

1079. Intensity of Reflection of X-Rays from Diamond. Alice H. Armstrong. *Phys. Rev.* 34. *pp.* 1115–1121, *Oct.* 15, 1929.

Ionisation spectrometer measurements of the intensity of reflection of the $K\alpha$ doublet of molybdenum by fine diamond powder were made by the transmission method. The diameter of the individual particles was 10^{-4} cm. or less, whereas 3×10^{-5} cm. is the length of the cube edge of a block small enough so that primary extinction, calculated from Darwin's formula, should be less than 1 %. Secondary extinction was probably negligible. The relative intensities of the radiation reflected from the different planes of the diamond were obtained by comparisons of the areas under the peaks. From these relative intensities the relative F values were obtained by using a formula derived by Compton and modified to fit the conditions of this experiment. These relative values were placed on an absolute scale by comparing the intensity of the (220) reflection of diamond with that of the (220) reflection of NaCl, for which the absolute value has been determined. The (222) reflection, previously observed by W. H. Bragg and by Ehrenberg, Ewald and Mark in studies of single crystals, was also observed here. It might occur if the carbon atoms are of two kinds with different scattering powers, or if adjacent carbon atoms shared electrons between them in such a way as to provide scattering centres upon the line joining them. Neither explanation, however, is entirely compatible with the experimental data. A Fourier analysis was applied to the data, and the resulting distribution curves were compared with those calculated by Havighurst from Hull's and Bragg's data. [See also Abstracts 137 (1922) and 2715 (1925).] AUTHOR.

1080. Scattering of Short-Wave Radiation by Atoms in Accordance with Dirac's Theory of Radiation. I. Waller. *Zeits. f. Physik,* 58. 1–2. *pp.* 75–94, 1929.

Atomic scattering of short-wave radiation is discussed in accordance with Dirac's theory, and a scattering formula, previously derived [see Abstract 525 (1929)], is more rigorously established. The effect of electronic scattering within the atom is discussed. J. S. G. T.

1081. X-Ray Diffraction by Plane Gratings. J. A. Prins, *Nature,* 124. *p.* 370, *Sept.* 7, 1929.

Bäcklin and, later, Bearden have made precision measurements on X-ray diffraction by plane gratings [see Abstract 3580 (1929)]. Their results gave values for the wave-length which are slightly higher than those calculated from crystal reflection measurements, and they conclude that the accepted value of Avogadro's number is slightly in error. Part of the discrepancy may, however, be due to the fact, as shown by Porter [see Abstract 2399 (1928)] that the usual diffraction formula needs a correction when applied to X-rays, due to the fact that a divergent beam is broadened asymmetrically by diffraction at a plane grating. Methods are suggested for eliminating this effect. The writer also comments on the intensity of grating spectra, and has made experiments on this point, allowing an X-ray beam to fall on a plane grating with varied glancing angles of incidence. An explanation is given of the results obtained. T. B.

1082. X-Ray Diffracting Power of Copper and Iron for Molybdenum and Copper Radiation. Alice H. Armstrong. *Phys. Rev.* 34. *pp.* 931–936, *Sept.* 15, 1929.

Ionisation spectrometer measurements were made of the intensity of reflection of the Kα doublet of Mo and Cu from copper and iron powders. From the relative intensities of reflection from the different planes of the powdered crystals, the relative F values for these reflections were calculated. These relative values were placed on an absolute scale by comparison of the intensity of one reflection with that of the (220) reflection of NaCl, for which the absolute value with Mo radiation has been determined by James and Firth. On the assumption that the atomic scattering factors are independent of the wave-length and are proportional to $\sin\theta/\lambda$, the same absolute value of F was used for the (220) reflection of Cu Kα from NaCl. Because of the difficulty experienced in making plates of the copper and iron powders sufficiently thin for use in absorption measurements, previously determined values of absorption were used in the calculation of the absolute values. Calculated values of the absorption coefficient for NaCl were used. The absolute values of F are shown as functions of $\sin\theta/\lambda$. Those for Cu radiation do not lie on the same curve as those for Mo. The fact that the two curves do not coincide suggests that the assumption that F_{220} for NaCl is the same for Cu as for Mo radiation may not be justified, and that F is not entirely independent of the wave-length. AUTHOR.

1083. M-Series of the Rare-Earths. E. Lindberg. *Zeits. f. Physik*, 57. 11–12. *pp.* 797–803, 1929.

In the series of elements Ce(58) to lutecium Lu(71) the valence electrons undergo no change, but instead of that an inner quantum level, the 4_4 level, is formed, and a difference in the electron arrangement has a smaller influence on the chemical properties of the elements. In the periodic system the series Ce to Lu is the most extreme example of the existence of an electron group deep down in the atom. The present investigation is a continuation and extension of an earlier one on the M-series which covered the range V(92) to Gd(64). The observations were made with a vacuum spectrograph of the Siegbahn type. Mica was used for the crystal, and the time of exposure ranged from 1 to 5 hours, with one or more renewals of the anti-kathode material. Sulphates of most of the metals were used. An oxide kathode was employed in all cases for the photographs. Sixteen short tables give the results obtained. T. B.

RADIOACTIVITY.

1084. Stability of Atomic Nuclei in Wave Mechanics. J. Kudar. *Zeits. f. Physik,* 57. 9–10. *pp.* 710–712, 1929.

Gives a new formula for the atomic diameter which yields smaller diameters than those calculated by Sexl both for electrons and protons. [See also Abstract 1894 (1929).] E. E. F. d'A.

1085. Structure of the Atomic Nucleus. G. Gamow. *Phys. Zeits.* 30. *pp.* 717–720, *Oct.* 15, 1929. *Paper read before the Theoret. Physikal. Conference, Charkow, May,* 1929.

Develops the idea that the α-particles and extra electrons in the nucleus are held together in a conglomerate by surface tension, which compensates the inner pressure caused by the zero point energy of the α-particles. Neglecting the Coulomb forces, the nuclear " drops " have always negative energy, and such a structure must be stable. Considering the Coulomb forces, however, a very large nucleus is unstable, which accounts for the radioactivity of the heavy elements. Shows how wave mechanics explains the escape of an α-particle from a radioactive nucleus, and how the same considerations apply when a light element is disintegrated by bombardment with α-particles; in both cases there is a possibility, which is not zero, that an α-particle may be able to pass through the potential threshold surrounding the nucleus, even when the energy of the particle is, according to the classical theory, too small to allow it to surmount the threshold. The phenomena of absorption of nuclear γ-rays in passing through the extra-nuclear system by electrons take place in such a way as to indicate a strong inner coupling between the outer electrons and the nucleus. This coupling almost destroys the boundary between the nucleus and the rest of the atom. H. N. A.

1086. Theory of Nuclear Disintegration. M. Born. *Zeits. f. Physik,* 58. 5–6. *pp.* 306–321, 1929.

It is shown in this paper that the disintegration probability of nuclei may be deduced from the known conception of quantum-mechanics transition probability. For two different models the disintegration probability has been calculated as a function of the α-ray energy.

H. H. Ho.

1087. Invariability of Radioactive Constants. (Mme.) P. Curie. *J. de Physique et le Radium,* 10. *pp.* 329–336, *Sept.,* 1929.

A concise summary of various experiments made during several years with a view to testing the regularity of radioactive transformations. Some of these experiments were made with the object of influencing the radioactive constants; others in order to investigate certain anomalies which seemed to indicate a possibility of variation of these constants. The method employed consisted in the measurement of the ionisation current obtained by means of a radioactive substance. A compensation method was used to measure the difference of the ionisation currents produced under similar conditions by two specimens of a radioactive substance, one of which was subjected to a certain treatment, whilst the other served as standard of comparison. In no case has the author been able to establish with certainty a departure from the laws generally recognised, although certain details have remained unexplained. One object of the paper is to draw attention to the difficulties which occur in the study of problems of this kind. J. J. S.

1088. Radioactivity of Polonium. L. Bogoïavlensky. *J. de Physique et le Radium*, 10. *pp.* 321–328, *Sept.*, 1929.

A description is given of experiments on the determination of the radioactive constant of polonium and of its period. Divergences occur in the numbers obtained by different investigators, which may vary up to 10 %, and the author suggests that this variability in the results may be due to causes such as oxidation of the metallic surface by the oxygen of the air and diffusion of polonium across the metal. The author also found a variation of the period with the locality whence the polonium came. **(Mme.) P. Curie**, in a note following the paper, considers that there is need for a more rigorous control of the results given by the author. J. J. S.

1089. Use of Radioactive Recoil in Measurements of Diffusion. G. v. Hevesy and W. Seith. *Zeits. f. Physik*, 56. 11–12. *pp.* 790–801; *and* 57. 11–12. *p.* 869, 1929.

A layer of $ThBCl_2$ was deposited on a $PbCl_2$ surface, and the recoil activity was measured by collecting the recoil product, ThC″, on copper foil charged to − 220 volts, and observing the β-rays given out by it. The $PbCl_2$ pastille was then heated, and the recoil activity was redetermined. The diminution observed was due to diffusion of ThB^{++} ions into the $PbCl_2$, to such a distance that the recoil atoms could not pass through a thin layer of $PbCl_2$ to the surface, but remained imprisoned. This gives an exceedingly sensitive method of determining diffusion constants as low as 10^{-13} cm.^{2} days^{-1}, and makes it possible to measure the diffusion velocities in $PbCl_2$ and PbI_2 down to about 100° C. Since ThB is an isotope of Pb this makes it possible to obtain probable values for the self-diffusion of lead. The results are shown to be consistent with Tubandt's discovery that in lead chloride electrical conductivity is due almost entirely to movements of the chlorine ions. The value of the velocity of diffusion of lead ions in lead iodide, calculated from the electrolytic conductivity and Tubandt's transference number, agrees well with the authors' result. H. N. A.

1090. Activation in Rare Gases. M. Laporte and L. Goldstein. *Comptes Rendus*, 188. *pp.* 689–691, *Oct.* 28, 1929.

To verify that recoil atoms are all positively charged at the moment of formation, the yield, *i.e.*, the ratio (RaA + RaB + RaC collected)/(total active deposit in equilibrium with amount of radon present), was determined in air and in pure argon for pressures up to 85 cm. of mercury, using 3 millicuries of radon and a voltage of 85 between electrodes. The yield (i) never exceeded 50 %, and (ii) was uniformly less in argon than in air. Causes for (i) suggested are (*a*) recombination of recoil atoms with negative charges in the gas; (*b*) electrostatic action of the walls of the vessel; and (*c*) velocity of recoil atoms so great that the field is insufficient to bring them to the electrode. As regards (ii) for pressures above 85 cm. of mercury, ionisation by collision is apparent in argon, so that (*a*) is of greater effect therein, an explanation supported by the fact that in argon increased voltage causes decreased yield. C. A. S.

1091. Rate of Emission of α-Particles from Radium. F. A. B. Ward, C. E. Wynn-Williams and H. M. Cave. *Roy. Soc., Proc.* 125. *pp.* 713–730, *Nov.* 1, 1929.

The number of α-particles emitted per sec. by 1 gm. of radium has been determined by a direct counting experiment with a new type of electrical counter in which the whole of the amplification was produced by triode valves. The amplification was linear, so that the counting of α-rays was undisturbed by the presence of β-rays. It was found possible to count with accuracy at a high rate, *i.e.*, about 500 particles per min. Approximately 10^5 α-particles were counted, and the value found for the rate of emission from radium was $3 \cdot 66 \times 10^{10}$ α-particles per sec. per gm. of radium, in good agreement with the value of $3 \cdot 69 \times 10^{10}$ recently found by Braddick and Cave, and with recent measurements of the heating effect of radium and its products. AUTHORS.

1092. Collision Between Free and Bound α-Particles. J. Kudar. *Zeits. f. Physik*, 58. 1–2. *pp.* 129–133, 1929.

A radioactive nucleus containing an α-particle of energy E, which is spontaneously emitted in the disintegration act, is bombarded with α-particles of energy $E' > E$. The author considers the possibility of collisions between the bound and the free α-particle inside the nucleus, and using wave mechanics derives an expression for the probability of such collisions. W. S. S.

1093. Quantum Mechanics of α-Radiation. R. d'E. Atkinson and F. G. Houtermans. *Zeits. f. Physik*, 58. 7–8. *pp.* 478–496, 1929.

The quantum mechanics formula for the decay constant of α-rays is deduced, with accurate consideration of the limiting conditions, on the basis of Gamow's theory, whereby the decay energies appear as particular values of the energies of a schematised potential range, which must be characterised by two constants. J. J. S.

1094. Straggling of β-Particles. E. J. Williams. *Roy. Soc., Proc.* 125. *pp.* 420–445, *Oct.* 1, 1929.

The energy of electric particles is reduced on passing through a sheet of matter. Particles incident on the foil with the same energy emerge with different energies. This dispersion of the energy caused by the foil is known as the "straggling" of the particles. In the present paper a theory of the straggling of β-particles by thin foils is developed. The theoretical distribution of the losses of energy by β-particles traversing thin foils is calculated. The classical theory gives the *shape* of the observed distribution curves, but the *absolute magnitude* of the classical straggling is $2 \cdot 3$ times less than the observed. Thus, collisions in which a fast β-particle loses energy of the order of 1000 volts are $2 \cdot 3$ times more frequent than is required by classical theory. A brief outline of certain new ideas concerning the nature of collisions is given. J. J. S.

1095. Transmission of β-Rays through Magnetised Iron Foil: An Attempt to Polarise a Beam of Electrons. F. E. Myers and R. T. Cox. *Phys. Rev.* 34. *pp.* 1067–1068, *Oct.* 15, 1929.

This paper describes an attempt to polarise a beam of β-rays by transmission through two magnetised iron foils, the first being regarded as the polariser and the second as the analyser. Radium was used as the source of electrons and a Geiger counter to give the number penetrating both foils with varying angles between their directions of magnetisation. The data, representing the transmission of some quarter of a million electrons, give no evidence of such polarisation. AUTHORS.

1096. Test for Polarisation in a Beam of Electrons by Scattering. C. T. Chase. *Phys. Rev.* 34. *pp.* 1069–1074, *Oct.* 15, 1929.

This paper contains a final report on the researches commenced by Cox, McIlwraith and Kurrelmeyer [see Abstract 3259 (1928)], and reported by them in preliminary fashion. High-speed β-particles from radium impinge on lead targets and are twice scattered at right angles. The doubly scattered electrons are counted by a point-discharge counter, the number counted at various azimuthal angles being studied, as the radium and upper target are rotated as a unit with respect to the counter and lower target. Experimental refinements have increased the total number of countable electrons and have eliminated the counts due to γ-rays, which were very troublesome in the earlier experiments. Counts taken at four azimuthal angles separated by ninety degrees show no effect of the kind suspected by Cox, McIlwraith and Kurrelmeyer, nor any effect of the kind which occurs when X-rays are twice scattered at right angles. More than 45,000 electrons were counted. The experimental error is less than 1 %. It is concluded that high-speed β-rays are not polarised by scattering. AUTHOR.

1097. Relative Brightness of Scintillations Produced by H-Rays with Different Ranges. (Miss) E. Kara-Michailova and (Miss) B. Karlik. *Akad. Wiss. Wien, Ber.* 138. *2a.* 7. *pp.* 581–587, 1929.

It was to be expected that the relation between the brightness of the scintillations for different sizes of crystal grains in the scintillating screens would follow similar laws to those already found for α-rays. For the same velocity an α-scintillation should theoretically be four times as bright as an H-scintillation. Details are given of the experimental method adopted, with which two screens were tested, one with particles of 40 to 50 μ diameter and the other with 7 to 12 μ diameter. The curves obtained with H-rays show the same differences as in the case of α-rays for the two screens. The mean value obtained for the ratio between the brightness of the two kinds of scintillation, with equal residual range, was about 1 : 5 instead of 1 : 4 as expected from theory. The difference is probably due to unavoidable observational error. H. N. A.

1098. Measurements of Penetrating Hess Radiations at Considerable Depths in Water. E. Steinke. *Zeits. f. Physik*, 58. 3–4. *pp.* 183–193, 1929.

Measurements have been made at depths below the surface of water which, reckoned from the outer limit of the atmosphere, amount to 50 metres. The apparatus was self-registering, its residual rate when all external radiation was cut off had been determined, and any radioactive radiation from the water was screened off by a leaden armour. There was a continuous falling off of the coefficient of absorption of the Hess radiations as the depth increased, which is a further proof of their lack of homogeneity. An attempt is made to explain the differences in the measurements obtained by previous authors by assuming different spectral sensitiveness in their instruments. Some remarks are made as to the nature of the Hess radiation in view of the recent suggestion of Bothe and Kolhörster that it is of a corpuscular nature, and some difficulties in the way of this theory are brought forward. H. N. A.

1099. Experimental Investigation of the Electron Counter. H. Geiger and W. Müller. *Phys. Zeits.* 30. *pp.* 489–493, *Aug.* 15, 1929.

The authors have already described an electron counter [see Abstract 1237 (1929)] which may be used for the quantitative investigation of extremely weak radiations of either atomic or corpuscular nature. The apparatus simply consists of a metal tube with an axial fine wire whose surface is coated with a half-insulating skin. In consequence of this skin the potential on the wire may be raised so high that on the entry of even weak β-radiation the ionisation by collision makes it easy to observe the incidence of the β-radiation with an instrument of normal sensitivity. The present series of experiments were made to test the working of the counter under various conditions. It is shown that the number of secondary β-rays observed when weak γ-rays fall on the counter is practically constant as soon as the pressure increases to more than 5 cm. mercury. Even at 1 mm. pressure, however, a considerable fraction of the maximum number of particles is observed. The effects of varying the type of gas (A, H_2, Air, CO_2) and the diameter of the central wire are discussed. Over a considerable voltage range with a "good" wire the number of observed impulses per min. remains constant (1300–1600 volts). Practical hints for the detection of "good" and "bad" fibres are given. The sensitivity of a counter along the length of its axis was investigated by using a narrow bundle of β-rays from RaD + E: the sensitivity remains constant over most of its length, but drops near the insulators at the ends of the tube. Experiments with tubes of various materials (paraffin, Al, Fe, Ni, brass, Zn, lead) show only small variations except in the case of lead. The directional effects of the secondary β-rays produced by γ-rays may be easily demonstrated. For cosmic rays such asymmetry is not observed as would be expected if they are indeed corpuscular as suggested by Bothe and Kolhörster. The experimental evidence is marshalled to show that the counter records all the β-rays falling on it. The paper contains much useful experimental information and should be consulted for detail. W. V. M.

1100. Measurement of Radium Preparations by the γ-Ray Method Using an Electron Counter. H. Neufeldt. *Phys. Zeits.* 30. *pp.* 494–495, *Aug.* 15, 1929.

The smallest quantity of radium that can be measured by comparison with a standard preparation is about 10^{-2} mg., but by the use of the Geiger electron counter much smaller quantities may be dealt with. A counter is described consisting of concentric cylinders, the radium being placed in the centre of the apparatus, while between the cylinders four wires are stretched. For three specimens of radium containing approximately 10^{-6} mg., the number of observed particles per minute per mg. was constant. For very small quantities such as these, in order to obtain accurate results, the observations must be continued for some time. Thus, in order to obtain an accuracy of 10 % for 10^{-6} mg. Ra, the observations must continue for six hours. Such experiments are made considerably easier by the use of automatic counting devices. A description is given of a measurement of small quantities of radium by this method, which is about a thousand times more sensitive than previous methods. W. V. M.

HEAT.

1101. Thermal Conductivity of Powders at High Temperatures. M. Pirani and F. v. Wangenheim. *Zeits. f. techn. Physik*, 10. 10. *pp.* 413–424, 1929.

The heat is supplied by a central cylindrical conductor heated electrically, round which the powder is packed. The apparatus is placed in an oven, the temperature of which can be adjusted. The current is varied so that the inner heating cylinder is at some known temperature above that of the oven. Knowing the energy supply and the temperatures, the thermal conductivity can be found. The apparatus gives results over the range 100°–1000° C. Data are given relating to some powders of technical importance—kieselguhr, carborundum, etc. A. A. D.

1102. Stability of a Layer of Viscous Fluid Heated from Below. A. R. Low. *Roy. Soc., Proc.* 125. *pp.* 180–195, *Aug.* 1, 1929.

Jeffreys has reduced the problem to the solution of a differential equation of the sixth order with constant coefficient, and has devised a method of solution by expressing the sixth derivative of an assumed solution by a Fourier series. The present paper is a formal solution of Jeffreys' differential equation by the usual methods. F. S.

1103. Total Radiation from Nickel and Cobalt. C. L. Utterback. *Phys. Rev.* 34. *pp.* 785–790, *Sept.* 1, 1929.

Measurements have been made on the total radiation from nickel between 630° K and 1600° K and from cobalt between 672° K and 1590° K. The radiation was measured by means of a platinum-tellurium thermocouple and a high-sensitivity galvanometer. A constant deflection method was used. The temperature of the metal was measured by means of a Holborn–Kurlbaum type of optical pyrometer, calibrated at the gold and palladium points, and by means of a platinum platinum-rhodium thermocouple. A comparison of the radiation with other properties of the metals is given. [See next Abstract.] AUTHOR.

1104. Total Radiation from Polished and from Soot-Covered Nickel. B. T. Barnes. *Phys. Rev.* 34. *pp.* 1026–1030, *Oct.* 1, 1930.

Total radiation data were obtained on polished nickel and on the same metal when covered with soot. Temperatures below the range of an optical pyrometer were determined from a log-resistance and log-temperature curve obtained from resistance measurements on the wire mounted in a lamp in a furnace at known temperatures and extended up to the point obtained when using a pyrometer. The log-resistance and log-temperature curve had a sharp break at the magnetic transformation point just as noted by previous investigators. This break occurred at about 360° C. In the region from 800° to 900° the total radiation values for unpolished nickel deviated somewhat from a smooth curve through the values at lower and higher temperatures. This may be due to an error in drawing the log-resistance and log-temperature curve since there were no resistance temperature measurements form 500° to 725° C. between the range of the furnace readings and that of the pyrometer. Total emissivity values for soot-covered nickel range from 0·92 at 400° K to a minimum value of 0·81 at 800° K, then rise to 0·86 at 1100° K. The total emissivity of polished nickel was found to be 0·205 at 1400° K. At 400° K it was 0·087 before heating to incandescence, and 0·063 afterwards. At intermediate temperatures there were similar differences due to surface changes during the initial heating. [See preceding Abstract.] AUTHOR.

1105. New Fusion Calorimeter. H. Sachse. *Zeits. f. phys. Chem.* 143. *Abt. A.* 2. *pp.* 94–96, *Sept.*, 1929.

The author describes briefly with a sketch a fusion calorimeter which closely resembles the Bunsen ice calorimeter in form and arrangement, but is more sensitive and more convenient in operation. The dilatometer fluid is diphenylether, which melts at 26·55° C. The calorimeter is placed in a water thermostat which is kept at a constant temperature within ± 0·005° C. By direct reading on a graduated capillary, 0·1 calorie can be measured. The instrument is specially suitable for slow heat changes, such as the decomposition of hydrates and dissociation phenomena. T. B.

1106. Construction of Micro-Thermopiles. D. M. Whitaker. *Science*, 70. *pp.* 263–266, *Sept.* 13, 1929.

The construction of very small and very sensitive thermocouples is described. Very fine wires are produced by drawing out small gauge wires encased in fused quartz or pyrex glass, when heated by a very small but intense gas or oxygen-gas flame. The method can be applied to platinum, iron, silver, copper, etc., but constantan is difficult, and bismuth is brittle. Details are then given of soldering the elements together, and the best method is by electrodeposition of silver. Full details of construction are given, and, in combination with a sensitive Leeds and Northrup galvanometer, a temperature change of 0·0005° C. can be determined without use of a relay. Hence, the instrument is suitable, by micromanipulation, for the measurement of temperature changes in small living cells or tissues, such as a single plastid. B. J. L.

1107. Automatic Regulation of Temperatures up to 600° C. by Means of a Platinum Resistance Regulator. E. A. Cooke and J. C. Swallow. *Journ. Sci. Instruments*, 6. *pp.* 287–293, *Sept.*, 1929.

A method of temperature control for thermostats or air ovens depending on the change of electrical resistance of a platinum wire with variations of temperature is described. Provided use is made of a suitable thermionic valve relay the temperature control is accurate to ± 0·1° C. at 350° C. and to ± 0·2° C. at 600° C. AUTHORS.

1108. Wollaston Wires and Foils and their Use as Resistance Thermometers. E. Waetzmann, M. Gnielinski and H. Heisig. *Zeits. f. Physik*, 58. 7–8. *pp.* 449–469, 1929.

An electrolytic process for the treatment of Wollaston wires proposed by Friese and Waetzmann was accurately tested and a description is given of the method and results. The tests were favourable to the process. Besides, an account is given of various electric and microscopic measurements applied to wires and foils, and, finally, some points relating to their use as resistance thermometers are dealt with. J. J. S.

1109. Thermoelectric Temperature Scales. W. F. Roeser. *Bureau of Standards, J. of Research*, 3. *pp.* 343–358, *Sept.*, 1929.

The International Temperature Scale [see Abstract 869 (1929)], adopted in 1927 by the Seventh General Conference of Weights and Measures, representing thirty-one nations, is the fourth thermoelectric temperature scale used by the Bureau of Standards since 1912. In putting this scale into use it was necessary for the Bureau of Standards to replace all of the fixed points used previous to 1926 by new fixed points specified in the International Temperature Scale. It is the purpose of this work to determine how much change this has caused in the temperature scale and to make available comparisons between the various scales used by the Bureau of Standards at different times since 1922. The difference between four thermoelectric temperature scales based upon (1) Sb, Ag and Au; (2) Zn, Sb, Ag and Au; (3) Zn, Al and Cu; and (4) Zn, Sb and Cu as calibration points have been determined. The maximum difference between (1) and (2) was found to be 0·1° C., between (1) and (3) 0·2° C., and between (1) and (4) 0·3° C. in the temperature range 660° to 1063° C. The freezing point of the copper-silver eutectic alloy, 71·9 % silver and 28·1 % copper, on the International Temperature Scale was found to be 779·4° C. ± 0·1° C. The difference between the freezing points of gold and copper was found to be 20·0° C. ± 0·1° C. The methods used at the Bureau of Standards in realising the International Temperature Scale in the range 660° to 1063° C. are described in detail. AUTHOR.

1110. Volume Changes during Solidification of Metals and Alloys. W. E. Goodrich. *Faraday Soc., Trans.* **25.** *pp.* **531–569,** *Oct.,* **1929.**

Gives the results of the investigation of the volume changes taking place during solidification of the metals Pb, Sn, Bi and Zn, and the alloys Pb-Sn and Bi-Sn, also the Pb-Sb alloys up to 25 % Sb; Sb-Sn alloys up to 15 % Sb, and certain other alloys. The alloys were prepared *in vacuo,* and the determinations made in an atmosphere of nitrogen. The Pb-Sn series shows a minimum contraction of 2·28 % with 48 % Pb. Increasing the proportion of Pb or Sn results in a proportionate increase of total contraction up to 2·97 % for pure Sn, and 3·85 % for pure Pb. Bi expands 3·47 %, and the expansion or contraction of Bi-Sn alloys depends on the proportion of the component metals. The contraction on freezing of pure Zn is 4·48 %, and the expansion on melting is 4·69 %. C. O. B.

1111. Melting Point of Palladium. F. H. Schofield. *Roy. Soc., Proc.* 125. *pp.* 517–531, *Oct.* 1, 1929.

Using an optical pyrometer of the disappearing filament type, the author determines the current in the pyrometer lamp required to give a match in brightness at a particular wave-length with a black body held at the melting point of gold. A similar measurement is made for palladium, employing a rotating sector to reduce the brightness to about the same intensity as at the gold point. The gold point is determined by three methods: " wire," " ingot," and " cone," the temperatures being measured simultaneously by a thermocouple. The " ingot " method gives the most reliable results. Only the " wire " and " cone " methods have been used with success for the palladium point. In the former the commencement of melting of the palladium wire is shown by the reading of the thermocouple, the arms of which are joined by the wire. In the latter the point at which the cone begins to collapse on melting is observed directly in the optical pyrometer. From these experiments the melting point of palladium on the International Temperature Scale, in which the melting point of gold is 1063° C. and c_2, the constant in the Wien equation, is 1·432 cm.

degrees, may be taken as 1555° C. to the nearest 1° C. The accuracy of the determination is estimated to be ± 2° C. A. J. M.

1112. Internal Specific Heat of Gases. W. Jazyna (Jacyno). *Zeits. f. Physik*, 57. 5–6. *pp*. 341–344, 1929.

A mathematical paper in which, assuming equal distribution of energy, the author calculates the "heat-molecular-weight" (Wärmemolekulargewichte) and the "absolute internal specific heat" of gases. The external specific heat C_x can be written $C_x = \text{Lim}\,(\Delta Q/\Delta T)_x = (dv/dT)_x + Ap(dv/dT)_x$ or $= C_s + (C_z - C_\mu)_x + A(np_i + p)\,(dv/dT)_x$, where C_s = the absolute specific heat; C_z = the specific heat of dissociation; C_μ = the heat of combustion. On the kinetic definition of temperature $C_{s2}/C_{s1} = m_1/m_2$, assuming now (in agreement with Boltzmann) that only a part of the kinetic energy represents the heat, the fictitious heat-molecular weight m' is introduced in the last equation instead of the molecular weight. For a monatomic molecule $m = m'$; for polyatomic molecules $m' = \theta$ m., where θ decreases as z increases. A table of values for sixteen gases is given. The values of C_s can be used to separate kinetic and potential energies in the liquid state. T. B.

1113. Anomaly of Water. W. Jazyna (Jacyno). *Zeits. f. Physik*, 58. 5–6. *pp*. 429–435, 1929.

An attempt is made in this paper to explain the anomaly of water between 0° C. and 4° C., by assuming that at 0° C. and 760 mm. pressure the melting of ice is not complete, but only 98·3% melts. Between 0°C. and 30° C. the melting or disruption of the remaining 1·7 % of ice takes place. Equations are developed for the internal energy and for the coefficient of expansion of water. The latter is calculated for temperatures between 0° C. and 30° C., and compared with the experimental values of Osborne, Scheel and Chappuis. [See preceding Abstract and following Abstract.] T. B.

1114. Internal Energy and Coefficient of Expansion of Water. W. Jazyna (Jacyno). *Zeits. f. Physik*, 58. 5–6. *pp*. 436–439, 1929.

This is an extension of previous work [see two preceding Abstracts], and gives the results of the calculation of the heat of water and the coefficient of expansion from 0° C. to the critical temperature. The critical state is characterised by the fact that in the equation $U - U_0 = 2\pi_v + \zeta$ the temperature energy ζ reaches a critical value. This critical value must satisfy the inequality $\frac{\pi_k}{2} < \zeta_k < \pi_k$, where ζ_k is not a constant, but its variations fix the limits of the critical state. Putting $\pi_k = n\zeta_k$ where n is fixed by the relation $2 > n > 1$, we get $U_k - U_0 = 2\pi_k + \zeta_k = (2n + 1)\zeta_k$, n is termed the "transition number." By the help of this number and Callendar's data for the critical state [see Abstract 254B (1929)] the author finds the heat of water to be 498 cal. The values of the internal energy and internal pressure between 0° and the critical temperature are also tabulated. T. B.

1115. Expansion and Pressure Coefficients of Gases and the Absolute Temperature of the Melting Point of Ice. L. Schames. *Zeits. f. Physik*, 57. 11–12. *pp*. 804–807, 1929.

For the normal state of a gas, we have with sufficient exactness $pv = RT\left(1 + \frac{B}{v}\right)$ and $pv = RT + Bp$. For the mean coefficient of expansion $\bar{\alpha}$ between 0° and 100° C. we get $\bar{\alpha} = \alpha_A + \frac{B_{100^\circ} - (1 + 100\alpha_A)B_{0^\circ}}{100} p_0$, and similarly $\bar{\beta} = \beta_A + \frac{1 + 100\beta_A}{100}(B_{100^\circ} - B_{0^\circ})p_0$, or $\bar{\alpha} = \alpha_A + x \cdot p_0$; $\bar{\beta} = \beta_A + y \cdot p_0$. The author calculates x and y from the values of B, and then the values of α_A, which correspond with $p = 0$. The results are:—

	10^7x.	10^7y.
He	-28	$-3{\cdot}6$
H_2..................	$-20{\cdot}8$	11
N_2	119	132
Air	129	137

and, finally, $T_0 = 273{\cdot}14^\circ \pm 0{\cdot}01$, which agrees with Roebuck's value 273·15° obtained from the Joule–Thomson effect for air. T. B.

1116. Isotherms of Hydrogen, Carbon Monoxide and their Mixtures. G. A. Scott. *Roy. Soc., Proc.* 125. *pp.* 330–344, *Sept.* 2, 1929.

The relation between pressure and volume is measured over the range 1 to 170 atmospheres by Natterer's method, which consists in filling a vessel of known volume with the gas at a measured pressure and then determining the volume after expansion to atmospheric pressure. The pure gases, and also three mixtures, were studied at 25° C. The results are expressed by means of equations of the form $pv_A = a + bp + cp^2$, with the following values of a, b and c.

Composition (% Hydrogen).	a	b	c
100	1·09090	$0{\cdot}6511\times10^{-3}$	$0{\cdot}033\times10^{-6}$
66·3	1·09109	$0{\cdot}4626\times10^{-3}$	$0{\cdot}947\times10^{-6}$
51·7	1·09122	$0{\cdot}3281\times10^{-3}$	$1{\cdot}28\times10^{-6}$
33·1	1·09142	$0{\cdot}1514\times10^{-3}$	$1{\cdot}88\times10^{-6}$
0	1·09196	$-0{\cdot}4393\times10^{-3}$	$3{\cdot}55\times10^{-6}$

These constants are not linear functions of the composition, and Dalton's law for mixtures is not obeyed exactly. J. H. A.

1117. Specific Heat of Gases at Middle and High Temperatures. A. Eucken, K. v. Lüde and G. Hoffmann. *Zeits. f. phys. Chem.* 5. *Abt. B.* 6. *pp.* 413–451, *Oct.*, 1929.

In Part I the specific heat of gases is measured by means of an adaptation of the Lummer–Pringsheim method, in which the exact estimation of the high temperatures is made possible by the use of an Edelmann galvanometer for the recording of the changes in resistance of the thermometer wire. The limits of error are defined and the precise evaluation of the experimental results is deduced from the characteristic formulæ. Over the temperature range outlined above CO, CO_2, and apparently also N_2O, give experimental values in close agreement to those obtained from the Planck–Einstein function, utilising the optically obtained value for the intermolecular characteristic frequency (*i.e.*, the band spectroscopic method). In contrast it was found that the values now obtained for N_2 and O_2 for the specific heat were approximately 13 % greater than those obtained by the optical method, whilst for CH_4 a semi-empirical formula is used. Full experimental details and tables of results are given. In Part II several modifications were made in the original method described in Part I, *e.g.*, in the pressure measurement with a quartz spiral, the substitution of platinum iridium wire, etc., in order to measure the specific heat of chlorine more exactly. The results were in good agreement with those obtained from the Planck–Einstein function. Full details are given. A vapour density measurement at − 28° C. is also made and discussed. S. G. B.

1118. Heat of Hydrolysis of Acetamide. E. Calvet. *Comptes Rendus*, 189. *pp.* 530–533, *Oct.* 7, 1929.

The author uses a compensated calorimeter in his experiments. The hydrolysis of acetamide can be considered as the result of two reactions, one of which, realised experimentally, has served as a base on which to calculate the thermic effect of the reaction. The arrangements made and precautions taken in the experiments are described. A table gives the principal results obtained. T. C. H.

1119. Vapour Tensions and Vapour Densities of Ethylene and Nitrous Oxide. G. T. Britton. *Faraday Soc., Trans.* 25. *pp.* 520–525, *Sept.*, 1929.

The vapour tension-temperature curves of nitrous oxide and of ethylene have been determined. Moderate agreement with previous workers in the former, and good agreement in the latter case is found. The pressure-temperature equation of Batschinski fits the data well. Measurements have been made of the vapour density of nitrous oxide at 20°, 45°, and 67° C., for which no previous data were available. AUTHOR.

1120. Vapour Pressures and Heats of Evaporation of Iron Pentacarbonyl. M. Trautz and W. Badstübner. *Zeits. f. Elektrochem.* 35. *pp.* 799–802, *Oct.*, 1929.

The vapour pressures of iron pentacarbonyl have been re-determined, and results are now given of measurements by the dynamic method. The temperature limits employed were 47·56° and 104·26° C. The molecular heat of vaporisation is 9·65 cal. at 23·78° C., and diminishes gradually to 8·70 cal. at 98·98° C. From the vapour pressures at 0° and 104·2° C. the mean value 9·38 cal. is calculated. T. H. P.

1121. Evaporation of Binary Mixtures. Part I. Determination of Heat of Vaporisation of Pure Liquids and Solutions. M. S. Wrewsky. *Zeits. f. phys. Chem.* 144. *Abt. A.* 3–4. *pp.* 244–252, *Oct.*, 1929.

The method is based on the determination of the quantity of vapour which is removed from the solution by the passage of dry gas through the solution and on the measurement of the quantity of heat required to compensate the cooling brought about by the passage of the gas. The apparatus, of which a sketch is given, consists of a glass calorimeter of 0·5 litre capacity contained in a metal box, which is surrounded by a double-walled thermostat. Dry air bubbles through the liquid in the calorimeter and passes out through a condenser, in which the vapour it carries with it is condensed and subsequently weighed. The heat required to compensate the cooling produced is determined by measuring the electric current sent through a spiral tube containing mercury, which is placed in the calorimeter. The method of conducting the experiment and making the necessary corrections is given. The value obtained for the latent heat of water at 79·3° C. is 552·4, and for a 53·66 % solution of H_2SO_4 595·1 cal. T. B.

1122. Molecular Forces. A. Eucken and L. Meyer. *Zeits. f. phys. Chem. 5. Abt. B. 5. pp.* 452–466, *Oct.*, 1929.

The vapour density of an organic vapour is measured to within an error of 0·8 % in an apparatus in which volume, molecular number and temperature can be treated as independent variables in the final deductions. This is described in detail. The results are applied to the determination of the virial coefficients (B-values) of benzol, carbon tetrachloride, ethyl ether, methyl alcohol, acetone, nitro-methane, and their relationship to temperature is recorded graphically. The experimental results are finally discussed from the theoretical standpoint. S. G. B.

1123. Generalisation of the Virial of Clausius. S. Ray. *Acad. Polonaise Sci. et Lettres, Bull.* 4–5 *A. pp.* 233–239, *April–May*, 1929.

In the kinetic theory of gases the virial of Clausius is given by $\Sigma\frac{1}{2}mc^2 = -\frac{1}{2}\Sigma(xX + yY + zZ)$, where c is the velocity of the individual molecule, and X, Y, Z the components of the force acting on that molecule. It is pointed out that (1) the result is not, as is usually assumed, independent of the origin of coordinates, but that the origin should be taken as the centre of the mass of the volume of gas; (2) force X and coordinate x have opposite signs. It is usually assumed, apparently in order that Gauss's transformation can be easily applied, that the pressure is the same at all points of the containing vessel. The author, on the other hand, assumes that the pressure may vary from point to point with distance from the walls according to an exponential law of the form $p = p_0e^{-kh}$. With this assumption of variability of pressure and density inside the volume of a gas the relation is rigorously obtained; virial of external forces $= 3/2\pi v$, where π is the average pressure and is defined by the relations $\iiint p\,dx\,dy\,dz = \pi v$. T. B.

1124. Entropy and Probability. W. S. Kimball. *J. Phys. Chem.* 33. *pp.* 1558–1578, *Oct.*, 1929.

The relation between the entropy, S, of a gas and the probability, W, of the state of the gas, is given by Boltzmann's relation, $S = k \log W +$ constant, where k is Boltzmann's constant. The subject has formerly been treated by (1) the method of collisions or kinetic method; (2) the statistical method. The present paper derives the equation by a new method in which all the mechanics concerned with entropy is concentrated into six mechanical axioms of *a priori* probability. These are then built upon by elementary probability methods, where the keynote is to measure probability by the range that includes each particle, doing it separately for each degree of freedom of each molecule, and taking the product to obtain the probability of the state of the gas. The method is essentially geometrical rather than statistical. T. B.

1125. Occurrence of Maximum Joule-Thomson Effect. L. Schames. *Zeits. f. Physik*, 57. 11–12. *pp.* 808–814, 1929.

This is a theoretical paper. It is shown from van der Waals' equation that the inversion curve of the differential Joule-Thomson effect cuts the vapour-pressure curve and the line $p = 0$, and passes into the area of negative pressure. In the stable state the greatest Joule-Thomson effect occurs at the intersection of the differential inversion curve and the vapour-pressure curve. This point is calculated for several gases from the results of experiment. The formulæ obtained are discussed by the help of a pressure-temperature-enthalpy diagram, in which the characteristic curves are drawn. The paper must be referred to for details. T. B.

1126. "Sama State" of the First and Second Kind. W. Anderson. *Zeits. f. Physik*, 58. 5–6. *pp.* 440–442, 1929.

By the Sama state is understood the temperature condition of a body in which a permanent temperature gradient is caused by the force of gravity alone. Much has been written on the possibility of such a state [see Abstract 550 (1929)]. Consider a very tall vessel with non-conducting walls to contain a little gas. The fastest moving molecules can only rise to a certain maximum height, say, $H_{max.}$ If the vessel is higher than this, the space above $H_{max.}$ may be free from gas and its temperature absolute zero. But as the average temperature of the gas is above zero, there must be a permanent temperature gradient. This is the Sama state of the first kind. A concrete example of the second kind may be given as follows: Suppose two exactly equal metal spheres at the same temperature to be connected by a very long thin wire. If a quantity of heat Q is given to one sphere, this will distribute itself between the two spheres, so that each has $\frac{Q}{2}$ units of heat, and the two spheres will have the same temperature. This statement, however, will be only true if the two spheres are at the same height. If the second sphere is higher than the first, work will be done against gravity when the energy rises, and the second sphere will be at a lower temperature than the first. Such a temperature condition is termed the Sama state of the second kind. T. B.

1127. Relationship between Gas Pressure and Translatory Energy of the Gas Molecule. W. Anderson. *Zeits. f. Physik*, 58. 5–6. *pp.* 443–446, 1929.

If $E_{trans.}$ represents the gas molecular translatory energy per c.c., v the linear velocity, and c the limiting velocity, the equation for the gas pressure is given by $p = \frac{1+\sqrt{1-\beta^2}}{3} \cdot E_{trans.}$, where $v/c = \beta$. Usually for gases at not too high temperatures v is very small compared with c, so that v/c is negligible as compared with unity. The expression for the pressure, therefore, becomes $p = \frac{2}{3} \cdot E_{trans.}$ If "light quantum gas" is considered, then $\beta^2 = 1$, and the formula becomes $p = \frac{1}{3} E_{trans.}$ Recently Schaposchnikow, Fedoroff and others have come to the conclusion that in the case of light quanta, besides the translatory energy, there is an equally great rotational energy in addition. The present results show that the above-mentioned authors have used the formula $p = \frac{2}{3} E_{trans.}$ for "light quantum gas," which, according to the above argument, is not allowable. It is, therefore, shown that the rotatory energy cannot exist in the case of the light quantum. S. G. B.

SOUND.

1128. Fourier Analysis Subject to Certain Quantum Condition. N. N. Bosc. *Acad. Polonaise Sci. et Lettres, Bull.* 4–5A. *pp.* 225–227, *April–May*, 1929. *In English.*

A brief note on a modified Fourier analysis applicable when the ratio of amplitude to wave-length is constant for the harmonics. W. H. Ge.

1129. Back Wave in Wave Motion. S. Ray. *Acad. Polonaise, Sci. et Lettres, Bull.* 4–5A. *pp.* 229–232, *April–May*, 1929. *In English.*

A brief discussion of anomalies which arise when simple treatments of wave-motion are applied to physical examples in which the speed of propagation depends upon the amplitude so that the wave-length depends upon the distance from the origin. W. H. Ge.

1130. Sound Waves due to Prescribed Vibrations on a Spherical Surface in the Presence of a Rigid and Fixed Spheroidal Obstacle. H. Sircar. *Tohoku Math. J.* 31. *pp.* 251–265, *Aug.*, 1929. *In English.*

Starting from the velocity potential of the unobstructed wave system diverging from a vibrating sphere in an unlimited medium, the author considers next the velocity potential of the wave system reflected from the surface of a spheroidal obstacle whose axis of revolution passes through the centre of the sphere. It is shown that the constants occurring in the expression for the velocity potential of the reflected system are determined by an infinite number of linear equations. The theory of the solution of such a system of equations has been developed by Poincaré, von Koch and others. When the dimensions of the spheroid are small compared with the wave-length, simple approximate formulæ for the constants are derived. The system reflected from the spheroid will be again reflected from the sphere, and it is shown that the coefficients in the velocity potential formula are in this case also determinate, as is the case for further successive reflections at the surfaces of the spheroid and sphere respectively. Similar treatment is given for the case where the sphere is situated inside the spheroid. A. W.

1131. Low-Frequency Sound Waves and the Upper Atmosphere. E. H. Gowan. *Nature*, 124. *pp.* 452–454, *Sept.* 21, 1929.

Describes instruments for the mechanical registration of sound waves, such as the hot-wire ammeter and the undograph. There are several indications to show that the rate of transmission of low-frequency waves is greater at a level of about 40 km. than on the ground. The supposition that above 30 km. the temperature of the atmosphere increases again with height until it reaches, or even surpasses, ground temperature, is sufficient to account for the abnormal zone of audibility. The velocity of 340 m./sec. at 40 km. indicates a temperature of about 15° C. there. Such high temperatures in the upper atmosphere were first indicated by a study of meteors, and it has recently been shown that the absorption of solar energy in the ozone layer (centre of gravity about 45–50 km.) is responsible for their maintenance. E. E. F. d'A.

ELECTRICITY AND MAGNETISM.

ELECTROSTATICS, TERRESTRIAL ELECTRICITY AND MAGNETISM.

1132. Photoelectric Investigations of Solid Dielectrics. P. Tartakowsky. *Zeits. f. Physik*, 58. 5–6. *pp.* 394–401, 1929.

Experiments referring to the photoelectric removal of electric charge from the surface of dielectrics are detailed. The long wave thresholds of the effect are determined for sodium chloride, mica and sulphur. The following are the results: sodium chloride, $\lambda_0 > 302$ and < 313 mμ; mica, $\lambda_0 > 254$ and < 265 mμ; sulphur, $\lambda_0 > 220$ and < 254 mμ. J. S. G. T.

1133. Ionisation of Solid Dielectrics by X-Rays. D. Nasledow and P. Scharawsky. *Ann. d. Physik*, 3. 1. *pp.* 63–90, *Oct.* 2, 1929.

The paper commences with a review of previous work on the processes occurring in dielectrics by J. J. Thomson and McClelland, Curie, Becquerel, Becker, Joffé, Röntgen, Grebe, Roos (in very great detail), Bjalobrjesky and Kusnezow. Then follows an experimental account of an attempt to study the ionisation in solid ceresine, when under Röntgen radiation. A very detailed account is given of the apparatus and method with numerous tables of data and curves. The ionisation current is found to be proportional to the square root of the radiation intensity, and from 322 to 1600 volts Ohm's law holds good with remarkable accuracy. The measurements now recorded show quite clearly that in the dielectric, stable secondary phenomena occur which are probably conditioned by the slow course of the ional processes in solid substances. H. H. Ho.

1134. Dielectric Constants and Molecular Structure of Carbon Disulphide and Nitrous Oxide. P. N. Ghosh, P. C. Mahanti and B. C. Mukherjee. *Zeits. f. Physik*, 58. 3–4. *pp.* 200–204, 1929.

The dependence of the dielectric constants of these two compounds on the temperature has been determined by a balance method, the results showing that neither compound possesses a permanent dipole moment, both being unpolar. The values of ϵ are $1 \cdot 002912$ and $1 \cdot 001050$ for carbon disulphide and nitrous oxide respectively. The unpolarity indicates that Maxwell's relation holds, the dielectric constant being equal to the square of the refractive index extrapolated for infinitely great wave-length. The unpolar nature of the nitrous oxide molecule follows also from the fact that this compound shows only a relatively weak Kerr effect, in spite of its marked optical anisotropy. The molecules of both compounds exhibit a linearly symmetrical structure. T. H. P.

1135. Effect of a Magnetic Field on the Dielectric Constant of Gases. A. Pützer. *Ann. d. Physik*, 3. 3. *pp.* 333–358, *Oct.* 30, 1929.

The effect of a magnetic field (8000 gauss) on the dielectric constants of O_2, H_2, CO_2 and N_2 has been examined, using a resonance method and Lissajous figures. No effect was found, although the method was capable of detecting a change of 2×10^{-3} in the dielectric susceptibility $\frac{\epsilon - 1}{4\pi}$.

A. A. D.

1136. Dielectric Absorption and Dielectric Loss. J. B. Whitehead. *Frank. Inst., J.* 208. *pp.* 453–468, *Oct.*, 1929.

Schweidler has shown how to calculate the relation between dielectric absorption and dielectric loss by making use of experimentally determined charge or discharge curves, and applying the Hopkinson-Curie principle of superposition. In the present paper the results of work on the dielectric properties of impregnated paper are recorded, the results being arrived at by Schweidler's method. The curves were obtained by a sensitive oscillograph capable of recording up to within 0·0015 sec. of starting. The test condenser was of cylindrical type. The dielectric loss found in this way is in close agreement with expected values. G. E. B.

1137. Dielectric Losses at High Frequencies. G. E. Owen. *Phys. Rev.* 34. *pp.* 1035–1039, *Oct.* 1, 1929.

The power loss in very small pieces of dielectrics in high-frequency alternating fields is measured by a calorimetric method in which the heat produced in the dielectric is compared with that produced in a resistor carrying a measured direct current. For vulcanised fibre, celluloid, rubber dam and glass the loss is found to be proportional to the frequency and to the square of the applied voltage. AUTHOR.

1138. Dielectric Constants of Electrolytes by the Static Balance Electrometer Method. A. P. Carman, O. B. Young and K. O. Smith. *Phys. Rev.* 34. *pp.* 1040–1041, *Oct.* 1, 1929.

The differential idiostatic electrometer method devised by A. P. Carman [see Abstract 418 (1925)] has been arranged so that readings can be made with conducting electrolytes by static balance. The thermal disturbances have been controlled by a special cooling water jacket, around the vessel containing the tested solution. A diagram showing the connections and special arrangements is given. [See also next Abstract.] AUTHORS.

1139. Dielectric Constants of Electrolytes by the Static Balance Electrometer Method. A. P. Carman and K. O. Smith. *Phys. Rev.* 34. *pp.* 1042–1044, *Oct.* 1, 1929.

Values of the dielectric constants of solutions of KCl, $CuSO_4$ and $BaCl_2$, are measured for normal concentrations of from 0·001 to 0·024 at temperatures between 25° C. and 26° C. and in fields of about 26·7 volts. The results are given in table and curves. The dielectric constants of dilute solutions are found to increase at first above that of water, and later to decrease. In the case of $CuSO_4$, the dielectric constant is greater than that of water. The results are consistent to 1 % of the mean, and have a probable accuracy of less than 2 %. The results are in general confirmation of those of F. J. Smale for dilute solutions (Ann. d. Physik, 60. 625, 1897). [See also preceding Abstract.] AUTHORS.

1140. Dielectric Polarisation Potential and Law of Superposition for Hard Rubber. H. H. Race and J. R. Campbell, Jr. *Phys. Rev.* 32. *pp.* 1031–1034, *Oct.* 1, 1929.

If a constant potential E_1 is applied to an imperfect dielectric like hard rubber, there is evidence that an electrical potential E_p is built up in the dielectric. If, after a long-time charge at E_1, the applied potential is suddenly reduced to a lower value E_2, current will flow in a negative direction if E_p is greater than E_2. Therefore a sample of hard rubber was subjected to several exactly similar conditions of charge at $E_1 = 884$ volts per cm., but different conditions of discharge in that E_2 was varied from

829 to 882 volts per cm. The results indicate that for hard rubber the polarisation potential built up during a long-time charge is approximately equal and opposite to the charging potential. Under the assumption that Curie's law of superposition held true for the existing conditions, the curve of current against time was predicted from data obtained for the same test piece over two years ago. The time when this current changed direction (measured from the instant the lower voltage was applied) was also predicted. The close correspondence between the predicted and actual curves bore out the truth of the law of superposition for the gradients used. [See also Abstract 1163 (1925).] AUTHORS.

1141. Temperature Sensitivity of the Molecular Polarisation of Gases and Vapours. R. Sänger and O. Steiger. *Helv. Phys. Acta.* 2. 6. *pp.* 411–418, 1929. *In German.*

Calculates from the dependency of the molecular polarisation on the temperature that the values of the molecular electric moments for methyl chloride, ethyl chloride and propyl chloride vapours are $1 \cdot 85 \pm 0 \cdot 01 \times 10^{-18}$, $2 \cdot 00 \pm 0 \cdot 01 \times 10^{-18}$ and $1 \cdot 90 \pm 0 \cdot 01 \times 10^{-18}$ respectively. Noticeable differences are shown between the molecular refraction and the term in the molecular polarisation formula which is independent of the temperature. [See also Abstract 2946 (1929).] R. C. F.

1142. General Polarisation Effect in Aromatic Molecules. W. A. Waters. *Phil. Mag.* 8. *pp.* 436–441, *Oct.*, 1929.

The general polarisation effect in aromatic molecules may be correlated with the dipole moment of the substituent group. By utilising the relationship $\log K_s/K_v \propto \mu$ the relative orders of magnitude of the reaction velocities of all meta-substituted aromatic compounds can be predicted from a knowledge of the electrical dipole moments of the substituent groups and *vice versa.* With para-substituted compounds the prediction is considerably less certain, and with ortho-substituted compounds no such prediction can be made. The hypothesis advanced is in complete harmony with earlier qualitative theories. AUTHOR.

1143. Anomalous Electric Dispersion in the Atmosphere. G. Petrucci. *N. Cimento*, 6. *pp.* 305–309, *July*, 1929.

There are periods of irregularity, with very powerful dispersion. The phenomenon is put in relation with the theoretical investigations of Brillouin on the states of equilibrium of an electric distribution in the air under the continued action of electric forces, of pressure and of gravity. A. D.

1144. Earth's Energy and Electrical Charge. G. Maneff. *Terr. Mag.* 34. *pp.* 225–229, *Sept.*, 1929. *In German.*

Values are found for the above quantities by means of the method of inversion of the gravitation and electromagnetic fields. Suggestions are also made with regard to the nature of the back current, and the physical cause of the earth's magnetism. The earth's charge, as determined, is of the same order of magnitude as that found from measurements of atmospheric electricity. G. E. A.

1145. Leak-Free Method of Measuring Air Potentials. O. H. Gish and K. L. Sherman. *Terr. Mag.* 34. *pp.* 231–237, *Sept.*, 1929.

A null method arrangement in which a guard-ring is employed is described. Details are given of measurements of air potentials in which a Wulf-type bifilar electrometer was used. J. J. S.

1146. Globular Lightning and its Surface Tension. E. Mathias. *Comptes Rendus*, 189. *pp.* 512–513, *Oct.* 7, *and pp.* 607–608, *Oct.* 21, 1929.

The way in which globular lightning passes through an orifice much narrower than its diameter is consistent with the theory that it is composed of a mass of gas enclosed by a layer possessing definite surface tension. The same assumption explains, on the analogy of Plateau's experiment with drops of oil suspended in a medium of equal density, its division into smaller spherical masses on shock, such subdivision increasing the stability of the system. Further, its division into two or more portions after coming in contact with a material such as iron is explained by the lowering of surface tension due to absorption thereof. C. A. S.

CURRENT ELECTRICITY, MAGNETISM AND ELECTROMAGNETISM.

1147. New Conception of the Mechanism of Metallic Conduction. H. M. Barlow. *Phil. Mag.* 8. *pp.* 289–304, *Sept.*, 1929.

The conducting electrons are supposed to be equivalent to an incompressible fluid rather than to a gas, as in Sommerfeld's theory. The electrons involved are those in the outer orbits, and are probably the valency electrons. An applied electric field distorts the orbits, and the electrons are handed on from atom to atom, usually pursuing zigzag paths. Mathematical relations between certain quantities are derived and are found to be in approximate agreement with observation. A. A. D.

1148. Sommerfeld's Electron Theory of Metals. R. Samuel. *E.T.Z.* 50. *pp.* 1481–1486, *Oct.* 10, 1929.

A general account of Sommerfeld's electron theory of metals. This theory differs from other attempts to bring about a better agreement between theory and experience in that it does not depend on altering the fundamental physical picture, but brings in another statistic of the "electron gas." A review is given of the foundations of the new statistic developed from quantum mechanics, and then the results at which the Sommerfeld theory arrives by this new statistic are considered. J. J. S.

1149. Electrical Conductivity Caused by Insoluble Monomolecular Films of Fatty Acid on Water. J. W. McBain and C. R. Peaker. *Roy. Soc., Proc.* 125. *pp.* 394–401, *Oct.* 1, 1929.

By means of films of insoluble fatty acid on water the authors tested the modern view of the existence of free mobile ions within the solution corresponding to free unbalanced charges on the surface. It was found that a monomolecular film of insoluble fatty acid on water consists partly of fatty ions whose corresponding H ions have dissociated into the aqueous layer. These free mobile H ions are revealed by the electrical conductivity which they impart to the aqueous layer in the neighbourhood of the surface. The specific surface conductivity at 25° C. in the neighbourhood of the monomolecular film of stearic acid is $3 \cdot 5 \times 10^{-8}$ mhos, corresponding to a dissociation of about one-ninth of the total stearic acid in the monomolecular layer on water of conductivity $1 \cdot 2 \times 10^{-6}$. The existence of the surface conductivity involving free mobile ions and corresponding charges left upon the interface supports the view that the electrokinetic phenomena are not due to the Helmholtz double layer, and that the classical formulæ are not strictly applicable, owing to the existence of unbalanced charges upon the interface. J. J. S.

1150. Temperature Law for Ionic Conductivity of Solid Lead Halides. A. Smekal. *Zeits. f. Physik,* 58. 5–6. *pp.* 322–332, 1929.

The Seith formula [see Abstract 749 (1930)] for the temperature-dependence of the bipolar ionic conductivity of lead iodide is revised and the anionic and kationic parts separated. Conclusions are arrived at for the mechanism of ionic conductivity and the Hedvall powder reaction. H. H. Ho.

1151. Ions in Solid Compounds. A. Smekal. *Zeits. f. Phys. Chem.* 5. *Abt. B.* 1. *pp.* 60–80. *Aug.,* 1929.

The author compared the conductivities of silver and sodium haloids. As representative of the former, silver iodide is distinguished by an extreme faculty of recrystallisation. It may, therefore, exhibit the phenomena of grid ions though most of the ions are loose. E. E. F. d'A.

1152. Conductivity of Ions in Crossed Electric and Magnetic Fields. L. Page. *Phys. Rev.* 34. *pp.* 763–771, *Sept.* 1, 1929.

The effect of collisions of ions moving through crossed electric and magnetic fields is investigated. (*a*) Collisions of ions with one another are shown to be without effect, the transverse current at right angles to the fields having the same value neu, where u is the velocity of progression, as would exist in the absence of collisions. (*b*) Collisions of free ions with neutral particles are investigated for the case where u is small compared to the speed v of thermal agitation. As the mean free path is increased the current parallel to the electric field increases to a maximum and then falls asymptotically to zero, the transverse current parallel to u rising from zero to the limiting value neu for infinite mean free path. Calculation of the Hall coefficient on the present theory, which differs from the usual theory in that it takes account of long free paths, shows that the coefficient increases with increasing magnetic field. AUTHOR.

1153. Distribution of Temperature Around a Constriction in a Conductor Asymmetrically Heated. C. Benedicks and J. Lindberg. *Arkiv f. Mat., Astron. och Fysik, Stockholm,* 21 *B.* 4. [5 *pp.*], 1929. *In French.*

Reference is made to the fundamental influence of the distribution of temperature around a constriction on the thermo-e.m.f. of a homogeneous circuit, and the experimental investigation quantitatively of this distribution previously made by one of the authors is shortly described. The results of the experiments carried out on a cylinder of soft steel show that the isothermals of the axial plane of the cylinder in the neighbourhood of the cylindrical constriction are sensibly confocal ellipses. The foci of the ellipses are situated centrally very near the periphery of the cylindrical constriction. It follows that the thermal conduction in the neighbourhood of the constriction is essentially along confocal hyperbolæ corresponding to the ellipses. Thus, if a hyperbolic form is given to the constriction the form of the isotherms should approach still more that of an ellipse. This conclusion has been verified and the subject is further discussed mathematically. J. J. S.

1154. Hall Effect, Electrical Conductivity and Thermoelectric Power of Copper-Tin Alloys. E. Stephens. *Phil. Mag.* 8. *pp.* 273–288, *Sept.,* 1929.

The electrical conductivity, temperature coefficient of resistance, thermoelectric power and Hall effect of the copper-tin series have been determined. The alloys were examined as chill cast and after annealing. All the curves show the presence of the compounds Cu_3Sn and Cu_4Sn. Although the Hall effect is negative for both tin and copper it is positive for both compounds and for certain ranges of the alloys. A comparison is made between the compounds in the present system and those in the copper-antimony system. A. A. D.

1155. Hall Effect and Conductivity of Silver Sulphide. F. Klaiber. *Ann. d. Physik,* **3. 2.** *pp.* **229–252,** *Oct.* **8, 1929.**

A Hall effect found between the two modifications of Ag_2S. On the transformation of rhombic $\sigma - Ag_2S$ into the regular $\alpha - Ag_2S$ at 179° C., the Hall constant falls from 20 $cm.^3$/amp. sec. to $0 \cdot 6$ $cm.^3$/amp. sec., while the conductivity rises from $1 \cdot 5$ ohm^{-1} $cm.^{-1}$ to 310 times that amount; $\alpha - Ag_2S$ has at the transformation-temperature a conductivity of 47 ohm^{-1} $cm.^{-1}$, about 100 times greater than the best-conducting melt-electrolyte. The product of the Hall effect into the conductivity lies for both forms of silver sulphide within the limits observed in metals. Solid silver iodide does not present any Hall effect. The bearing of the measured data upon the question of the process of conduction in silver sulphide is considered. A. D.

1156. Application of Thermodynamics to the Thermoelectric Circuit. P. W. Bridgman. *Nat. Acad. Sci., Proc.* 15. *pp.* **765–768,** *Oct.,* 1929.

The application of the first and second laws of thermodynamics to the thermoelectric circuit by Kelvin involved the assumption that the unavoidable irreversible processes of heat conduction and the generation of Joulean heat may be neglected in the argument. The present note show that by a rearrangement of the argument the equations of Kelvin can be rigorously deduced from thermodynamic principles without any assumption such as named above regarding the irreversible processes. The difference in the arrangement described from that of Kelvin is that matters are so arranged that all the input of energy is frittered away in the irreversible process of heat conduction from one temperature to another. Thus, Kelvin's first equation can be deduced. From the arguments put forward it appears that by arranging the couple so that the reversible effects result in the maximum possible dissipation of available energy, the difficulty of Kelvin's argument can be avoided. [See also next Abstract.] S. G. B.

1157. Nature of the Transverse Thermomagnetic Effect and the Transverse Thermoelectric Effect in Crystals. P. W. Bridgman. *Nat. Acad. Sci., Proc.* 15. *pp.* **768–773,** *Oct.,* 1929.

The close formal parallelism is noted between the Ettingshausen temperature gradient set up in an isotropic conductor at right angles to an electric current and a magnetic field and Kelvin's temperature difference between two opposite sides of a crystal rod, the length of which is oblique to the crystal axis and in which a longitudinal electric current flows. Geometrical similarity, reversal of sign with reversal of direction of current flow and proportionality to current strength are established. This analogy is carried through for other effects. The Nernst transverse e.m.f. under a longitudinal heat current and the longitudinal e.m.f. in a crystal produced by a transverse temperature difference are analogous. Similar relationship pertains between the Hall effect and the transverse potential gradient in a crystal carrying a longitudinal electric current due to the non-perpendicularity of the lines of current flow to the equipotential surfaces. The Righi-Leduc transverse temperature gradient is parallel to the transverse temperature gradient in a crystal carrying a longitudinal heat current arising from the fact that the lines of heat flow are not perpendicular to the surfaces of constant temperature. An attempt to look for an underlying similarity of mechanism in a crystal and an isotropic substance made non-isotropic by a magnetic field shows that in spite of the close analogy there is a fundamental difference of sign in the relations connecting the Ettingshausen with the Nernst coefficient and their corresponding crystal analogues, which indicates that the effects must be essentially different in character. After discussing the Bridgman and Lorentz methods of viewing the Ettingshausen effect as set out at the Solvay Congress, the necessity for conception of a thermomotive force is established. Finally, a formula is derived for the transverse Thomson heat which is shown to be analogous to that for the ordinary thermoelectric circuit, the argument following the lines of the previous paper. [See preceding Abstract.]

S. G. B.

1158. High-Intensity Non-Reversed Sodium Arc. C. J. Christensen and G. K. Rollefson. *Phys. Rev.* 34. *pp.* 1154–1156, *Oct.* 15, 1929.

An improved high-intensity sodium arc using the principle of the Cario-Holtgreven arc is described. This has sufficient of the second resonance radiation of sodium (3303 Å.) so that quite brilliant fluorescence is produced in sodium vapour when this radiation is used for excitation. [See Abstracts 2506 (1927) and 2728 (1929).]

AUTHORS.

1159. High-Frequency Spark Discharge in Air. T. Nishi and Y. Ishiguro. *Inst. Phys. and Chem. Research, Tokyo, Bull.* (*Abstracts*) 2. *pp.* 95–96, *Oct.*, 1929. *In English.*

Discharge phenomena in air were investigated at frequencies of 91 and 196 kilocycles per sec., using a 2-kW Poulsen arc generator. The sparking potential is shown to be considerably lowered in the case of non-homogeneous fields at high frequency. The effect of air flow on the flash-over voltage was studied and it was found that the increase of voltage for high frequency due to air flow (suction or air blast) was much smaller than for a frequency of 50 cycles per sec. No marked differences were observed on changing the frequency from 91 to 196 kilocycles per sec.; the length of corona became somewhat shortened and spread out, and the sparking potential in many cases was somewhat raised. Generally speaking, the characteristics of the h.f. discharge in air resemble those of the arc discharge at low frequency.

A. W.

1160. Relation between the Kathode Fall of Potential, the Length of the Dark Space, and the Current in the Electric Discharge through Gases. J. J. Thomson. *Phil. Mag.* 8. *pp.* 393–409, *Oct.*, 1929.

The relation between the thickness of the dark space, the kathode fall of potential, and the current is obtained both for the normal and abnormal discharge on the suppositions that: (1) the number of ions produced by an electron per cm. is proportional to $Kp(V - C)/\{(V - C)^2 + M^2\}$, where V is the energy of the electron in volts, C the ionisation potential, p the pressure, k a constant, and M the value of $V - C$ when the ionisation is a maximum; (2) that the electric force in the dark space at a point P is a linear function of the distance of P from the kathode (Aston's Law);

(3) that the number of electrons liberated from the kathode by the impact on it of a positive ion is $\alpha + \beta V^2$, where V is the energy of the ion; (4) that the relation between the potential difference V, the current density i, and the thickness of the dark space d is $id^2 = (\text{constant})V^{\frac{3}{2}}$. On these suppositions it follows that in the abnormal discharge V varies very nearly as $(i/p^2)^{\frac{2}{7}}$ and pd as $(i/p^2)^{-\frac{2}{7}}$, where p is the pressure. Thus V increases and d diminishes as the current increases. The theory shows that a transverse magnetic force would diminish the thickness of the dark space, and also that it would diminish the potential difference required to produce a very short spark. The first result is known to be true, and an experiment is described which shows that the second is also true. The investigation shows that the electronic collisions, though sufficient to account for the greater part of the ionisation, require to be supplemented by other agents such as radiation, and an experiment is described showing the great effect on the discharge produced by radiation from the negative glow. J. J. S.

1161. Kathode Phenomena in Geissler Discharges through Oxygen and Nitrogen. Nora M. Carmichael. *Phil. Mag.* 8. *pp.* 362–368, *Sept.*, 1929.

A search was made for a primary dark space in the Geissler discharges through O and N, with negative results. A new dark space in oxygen, between the negative glow and kathode dark space, is described. This appears to be a positive ion sheath between these two regions of the discharge. J. J .S.

1162. Influence of Removal of Gas from the Kathode on the Kathode Fall of Potential. G. Barth. *Ann. d. Physik*, 3.2. *pp.* 253–269, *Oct.* 8, 1929.

Experiments with copper and with platinum kathodes showed that the kathode fall of potential is increased progressively by removal of gas from the kathode and falls again if gas is again absorbed. Since the phenomenon is connected with the emission of secondary electrons from the kathode, it may be explained by the well-known phenomena observed in photoelectric measurements on incandescent metal foil. A. W.

1163. Sputtered Nickel Films. L. R. Ingersoll and J. D. Hanawalt. *Phys. Rev.* 34. *pp.* 972–977, *Sept.* 15, 1929.

Films of nickel have been sputtered in residual atmospheres of hydrogen, helium, nitrogen and argon, and the properties investigated. The gas content of the films is large, but generally less than one molecule per atom of metal. It is copiously emitted at 300–400° C., at which temperature the films become magnetic and better conducting. Evaporated films are found to occlude less gas than sputtered films under the same gas pressure, etc. When undue heating is avoided the films may be amorphous, or when produced in hydrogen or nitrogen may be crystalline with a lattice structure suggesting the existence of nickel hydrides and nitrides. Evidence of helium and argon compounds is lacking. [See Abstract 578 (1929).]

C. O. B.

1164. Action of High-Speed Kathode Rays on Acetylene. J. C. McLennan, M. W. Perrin and H. J. C. Ireton. *Roy. Soc., Proc.* 125. *pp.* 246–262, *Sept.* 2, 1929.

In a Coolidge kathode-ray tube acetylene was bombarded, the voltage and current being known and the pressure noted at different times. A pale-yellow solid was deposited on the walls of the reaction cell during the bombardment. It had no measurable vapour pressure and on bombarding it there was no increase in pressure. When heated the solid turned black and burnt with a luminous flame. No X-ray spectrum could be obtained from it. The rate of decrease of pressure of the acetylene is proportional to the pressure at any given voltage. The velocity constant of the reaction increased with increasing voltage. The number of electrons passing through the window of the kathode-ray tube was determined by collecting them in a Faraday cylinder and measuring the current. The number of molecules of acetylene reacting is of the same order as the number of ions produced by each electron that passes through the window. The observed facts can be explained on the hypothesis that the reaction takes place following the ionisation of the acetylene by the kathode rays. J. J. S.

1165. Diffraction of Kathode Rays. Part III. G. P. Thomson. *Roy. Soc., Proc.* 125. *pp.* 352–370, *Sept.* 2, 1929.

A new technique is described for making metal films of the order 10^{-6} cm. thick approximately free from holes, cellulose acetate being employed as base on which to sputter. Further electron diffraction rings were obtained and measured for gold, silver, lead, ion, nickel; attempts with tungsten and aluminium being unsuccessful. Apart from nickel the ring sizes agree with those to be expected from X-ray analysis data. Experiments with nickel films gave rings corresponding to hexagonal closest packing and not the familiar face-centred cubic pattern commonly accepted as the nickel structure and confirmed by the electron diffraction measurements of Germer and Davisson, and Rupp. Determinations of the lowest voltage for which rings could be obtained with the present films gave values ranging from 10,500 to 27,000 volts, whilst Rupp obtained rings using 180 volt electrons. Using photometric measurements of the diffraction rings in gold, a curve similar to the X-ray F-curve was obtained, giving the variation of electron wave scattering with angle, for the individual atoms. This curve falls much more steeply than the X-ray F-curve computed for the same metal. [See also Abstracts 1355 and 2801 (1928).] W. S. S.

1166. Ionisation of Air by Kathode Rays. A. Eisl. *Ann. d. Physik*, 3. 3. *pp.* 277–313, *Oct.* 30, 1929.

Calculates from measurements of the total ionisation produced in air by kathode rays of different velocities the value of the energy necessary to produce a pair of ions, indicated by ϵ, and examines the connection between the value obtained and the velocity of the ionising electron stream. The acceleration of the electrons was produced by alternating voltages between 10 and 60 kV, and the kathode rays of definite velocity were selected by means of magnetic bending at right angles. Measurements of the velocity lost by the electrons in passing through a celluloid foil which closed the entry tube were photographically obtained by magnetic bending in an evacuated chamber, whilst the electron and ion streams were measured electrometrically. It is found that, for velocities between 9 and 59 kV, the value for ϵ is a constant and independent of the velocity. The absolute value of the energy is found to be 32·2 ± 0·5 volts/pair of ions. R. C. F.

1167. Cylindrical Field in Ionised Air at Ordinary Pressure. Pauthenier and Mallard. *Comptes Rendus*, 189. *pp.* 635–637, *Oct.* 21, 1929.

In this paper the ionisation current which corresponds to the unit of length of a cylindrical condenser is investigated and a calculation made of the field deformation which it produces. H. H. Ho.

1168. Conductivity of Ionised Air at High Frequency. A. Székely. *Ann. d. Physik,* 3. 1. *pp.* 112–132, *Oct.* 2, 1929.

Determinations of the conductivity of ionised air in the negative glow discharge were made for currents of the frequencies $1 - 5 \times 10^6$ Hertz, that is, for wave-lengths between 242 and 58 metres. It was shown that the resistance of a plate condenser in the glow discharge (negative) depended on the frequency of the alternating current used for the measurements. The carriers of the electricity were considered to be the electrons which were in thermal equilibrium with the gas molecules. The confirmation of the theory obtained in this work was considered in its relationship to wireless telegraphy. F. J. B.

1169. Theory of Recombination of Gaseous Ions. L. B. Loeb and L. C. Marshall. *Frank. Inst., J.* 208. *pp.* 371–388, *Sept.,* 1929.

The bearing of the recent results of Marshall on the theory of recombination of gaseous ions is discussed. It is shown, by solution of the Brownian movement equation for two ions of opposite sign, that in a gas the average relative displacement in a time τ is little influenced by the attractive forces, except for distances of the order of magnitude of 10^{-5} cm. or less, at ordinary temperatures. This conclusion, that in general the motion of the ions relative to each other is largely one of random diffusion, is in good agreement with the interpretation forced by Marshall's study of the variation of the coefficient of recombination α with time and concentration of ions. This also indicates that the theoretical approach of Langevin to the solution of the recombination problem is untenable, while that of Thomson is justified. The theory of Thomson is discussed and is compared with observation. It appears to fit qualitatively as accurately as the facts are known. It is then shown how the success of any theoretical treatment is limited due to our ignorance of the nature of the mass of the ion, a condition which enables us, however, to understand the very small range of variation of α among the different gases. AUTHORS.

1170. Ionisation Currents from Zinc Oxide Smokes. H. P. Walmsley. *Phil. Mag.* 8. *pp.* 553–568, *Oct.,* 1929.

This paper describes the ionisation currents from clouds or smokes of zinc oxide particles and is supplementary to earlier work on the currents from clouds of cadmium oxide particles. A zinc oxide smoke is produced in a large cistern from, say, an electric arc between zinc electrodes. The initial ionisation and its time changes are measured as the smoke ages [see Abstract 2161 (1926)]. The ionisation currents from clouds dispersed in air from a zinc arc and from the decomposition of zinc ethyl have been described. The cloud particles in both cases are crystalline, with the internal structure of zincite. The clouds from the arc are ionised on formation; those from zinc ethyl are not. There seems to be a spontaneous production of ions in these clouds as they age. In the case of clouds from zinc ethyl the ionisation increases from zero to a maximum intensity and then diminishes. Qualitatively the intensity increases with the amount of material dispersed and with the degree of dispersion. The initial ionisation in clouds from the arc is attributed to thermoelectric emission of charges at the high temperature of formation. With arc cloud of low concentration this diminishes with time and is the dominant effect. The coefficient of recombination of these ions is found to be of the same order of magnitude as the coagulation constant of similar clouds. E. E. F. d'A.

1171. Raising the Flashing Potential of Neon-Argon Mixtures by Radiation. F. M. Penning. *Zeits. f. Physik*, 57. 11–12. *pp.* 723–738, 1929.

The author has previously shown that in the electric breakdown of neon-argon mixtures the ionisation of the argon atoms by metastable atoms of neon plays an important part [see Abstract 1014 (1928)]. If this assumption is correct, the effect of subjecting such mixtures to radiation of neon light should be to raise the flashing potential. This effect was observed and investigated as a function of the percentage of argon in the mixture, the pressure of the neon gas, the intensity of the radiation employed and the distance apart of the electrodes. The results are presented graphically. A. W.

1172. Photoelectric Effect in Glass Plates and its Dependence Upon the Angle of Incidence. A. Wehnelt and G. Schmerwitz. *Zeits. f. Physik*, 57. 7–8. *pp.* 533–538, 1929.

Reiger has shown experimentally that insulators show the photoelectric effect just like metals. The authors investigate the effect in the case of glass plates upon which polarised light is made to fall at various angles. The photoelectric current behaves precisely according to theory, rising to a maximum at the angle of polarisation at which the light is perfectly absorbed. After that angle is passed there is a rapid diminution of its effect. E. E. F. d'A.

1173. Change of Electrical State of Metallic Surfaces by Charging with Hydrogen Ions and by Electronic Bombardment. R. Suhrmann. *Zeits. f. Elektrochem.* 35. *pp.* 681–685; *Disc.*, 685–686, *Sept.*, 1929. *Paper read before the Deut. Bunsen Gesell., Berlin, May*, 1929.

Silver foil and gold foil supported on a copper rod were contained in a tube which could be evacuated. Hydrogen was admitted to the tube, and H-ions were generated by heating to redness a tungsten wire also contained in the vacuum tube. The electrical condition of the foil was then determined. It was found that by charging the gold or silver foil with H-ions by electronic bombardment, the sensitivity to photoelectric changes was increased to a marked degree, and the limit of the long-wave excitability was pushed forward. The ions were considered as remaining on the surface of the metals, and not forming chemical compounds. They were not removed by keeping for several hours in a high vacuum. The bearing of the results on heterogeneous catalysis was discussed, and the importance of the adsorbed H-ions in hydrogenation was pointed out.

F. J. B.

1174. Photo-Ionisation of Potassium Vapour. E. O. Lawrence and N. E. Edlefsen. *Phys. Rev.* 34. *pp.* 1056–1060, *Oct.* 1, 1929.

Using a space-charge-neutralisation method described in a recent publication the variation with wave-length of the ionisation per unit light intensity B_ν in potassium vapour has been studied. B_ν exhibits maxima in the range 2100 Å. to 3000 Å., one at the series limit 2856 Å., and another at 2340 Å., the magnitude of the latter maximum being three times the former. A minimum value of B_ν occurs close to 2700 Å. Former results are shown to agree with the present much more accurate data, though, because of the wide bands of wave-lengths used and the scantiness of observations, the earlier work failed to reveal the salient features here presented. The decrease of the ionisation efficiency on both sides of the series limit is similar to the corresponding variation in cæsium and rubidium, and it seems probable, though not here proved, that the ionisation by wave-lengths longer than the series limit is due to absorption of the principal series lines. The increase of B_ν beyond the series limit has been attributed in the past to ionisation of molecules. The present work shows that on this view the apparent molecular threshold occurs at 2700 Å., and not at 2550 Å. as estimated from earlier work. This fact in itself constitutes a serious objection to interpreting the observed variation of B_ν as a molecular phenomenon. It is pointed out that Williamson's observations of the emergent velocities of the photoelectrons show no evidence of molecular ionisation involving dissociation of the molecule and ionisation of one of the atoms. Also Ditchburn's observations of the continuous optical absorption due to potassium atoms agree qualitatively with the present results. It thereby appears probable that the observed dependence on wave-length of B_ν is an atomic property of potassium. AUTHORS.

1175. Electronic Emission in a Valve. L. Tieri and V. Ricca. *Accad. Lincei, Atti,* 9. *pp.* 872–875, *May* 19, 1929.

A further account [see also Abstract 907 (1929)] is given of experiments on the variation of the current that feeds an incandescent filament in a vacuum with variation of the electronic current between filament and plate, the negative of the plate battery being joined to the negative extremity of the incandescent filament. At different potentials of the plate, above a certain value V, to constant increments of the electronic current correspond equal variations of the current I of the filament; whilst for values of the potential decreasing from the initial value V the variation δI diminishes, becomes zero, and then is inverted. The experiments were carried out with a Philipps triode and have been confirmed with another triode with a pure tungsten filament. The interpretation of the results is to be discussed in a later note. J. J. S.

1176. Effect of Hydrogen on Thermionic Emission. H. R. Laird. *Phys. Rev.* 34. *pp.* 463–473, *Aug.* 1, 1929.

Thermionic currents frequently observed from potassium are due to hydrogen contamination, confirming the results of Fredenhagen. The larger currents were found to obey an equation of the Richardson type over a limited temperature range (150° C.–210° C.). The conductivity of a thin layer of potassium on a pyrex insulating tube was greatly decreased by exposure to hydrogen. E. E. F. d'A.

1177. Thermionic Emission and Surface Layers. C. Zwikker. *Phys. Zeits.* 30. *pp.* 578–580, *Sept.* 15, 1929.

In the thermal emission of metals there is a proportionality between the constants *b* and log A in Richardson's formula. The author has verified this for cases of platinum, zirconium, and hafnium. He points out that the inclination of the curve to the X axis is the same in all cases, being proportional to the absolute temperature. This is in accordance with theory. E. E. F. d'A.

1178. Incandescent Tungsten in an Atmosphere of Iodine. S. Kalandyk. *J. de Physique et le Radium,* 10. *pp.* 337–344, *Sept.*, 1929.

A continuation of the work on platinum in an atmosphere of iodine [see Abstract 581 (1929)]. The iodine diminishes the positive emission of a fresh filament, but not when it is previously heated. It increases the negative emission, especially at low incandescence. It also diminishes the emission of thoriated tungsten, but it does not influence the emission of oxidised tungsten. E. E. F. d'A.

1179. Selective Absorption and Reflection of Slow Electrons by Metals. E. Rupp. *Zeits. f. Physik*, 58. 3–4. *pp.* 145–164, 1929.

A number of different metals were formerly examined in the form of thin films, using slow electrons (40 to 4 volts), and absorption maxima were found for certain velocities. Experiments on reflection of electrons show similar reflection maxima at or about the same velocities. The form of the curves is characteristic for elements of the same vertical column in the periodic table, the positions of the maxima in a column and their heights showing regular shifts with the atomic number; the number of the maxima varies from column to column. The curves resemble those for the effective sectional area in gases which show the Ramsauer effect, though the conditions of the mutual action of electrons and atoms are very different in the two cases. It appears clear, however, that the exterior electrons of the atom are essentially concerned with the absorption, since metals of the same vertical column have the same type of curve, and the phenomena become more complicated in proceeding from column to column towards the right of the periodic table. The copper column elements have one maximum, the magnesium column two and the arsenic column three. The metallic lattice also, no doubt, affects the maxima.

H. N. A.

1180. Absorption Coefficient for Slow Electrons in Alkali Metal Vapours. R. B. Brode. *Phys. Rev.* 34. *pp.* 673–678, *Sept.* 1, 1929.

The absorption coefficient for electrons has been measured in the vapours of the alkali metals, Na, K, Rb and Cs. Measurements were made with a beam of electrons bent by a magnetic field through a series of slits arranged on a circle so as accurately to determine the velocity. The path length was kept constant while the pressure was varied by changing the temperature of the metal. The actual value of the vapour pressure is not known accurately and consequently the magnitude of the absorption coefficient is a little uncertain. The shape of the curve is independent of this uncertainty. The absorption coefficient for all the alkali metals increases monotonically from high to low velocity, except in the region of the critical potentials, where a sharp peak is superimposed on the monotonic rise. AUTHOR.

1181. Electron Emission and Diffraction by a Copper Crystal. H. E. Farnsworth. *Phys. Rev.* 34. *pp.* 679–696, *Sept.* 1, 1929.

A narrow beam of electrons of variable speed is incident normally on the (100) face of a copper crystal. Measurements of the total secondary electron current are obtained under the same conditions as the angular distribution of scattered electrons for bombarding potentials from 0 to 250 volts. The total secondary electron curve shows two maxima at 3 and 10·5 volts respectively, and many sudden changes in slope in the region between 10·5 and 250 volts. With two exceptions, all of the expected diffraction beams are found which are the X-ray analogues in the two principal azimuths, and in the range below 250 volts. In addition, 20 sets of beams are found, 12 of which satisfy the conditions required by a wave one-half the length given by $\lambda = h/mv$, or by a double-

grating spacing. Evidence of a selective angular distribution of emitted electrons, differing from that of the scattered electrons, is also obtained.
E. E. F. d'A.

1182. New Method of Vertical and Quasi-Horizontal Testing of the Atmosphere. J. Lugeon. *Arch. des Sciences,* 11. *pp.* 239–259, *Sept.–Oct.,* 1929.

Describes a method of testing the troposphere, stratosphere and the ionosphere, which is based on the complex photoelectric properties of the tangential rays of the sun as it passes through the crepuscular rings, on the electromagnetic field round a wireless receiving pole. Considering a station transmitting on a very long wave-length, the waves received by a distant receiving station have undergone a number of reflections. This also holds for the natural hertzian waves, and these latter only are considered, thereby eliminating the transmitter and allowing of the numerous peculiarities arising from the variations of their emission centres in the crepuscular rings to be studied. Commencing at sunrise no sudden change in field is to be observed, but as soon as the sun is high enough for its rays to be tangential to the highest ionised layer a sudden change in field is produced. These sudden changes occur every time the sun's rays become tangential to an ionised layer, rendering it possible to examine the state of the atmosphere at sunrise. From the results an empirical evaluation of the inversion temperatures can be obtained. A discussion of the electromagnetic peculiarities of the crepuscular ring is given, and it is further shown that, from quasi-horizontal testing, a measure of the longitude and latitude of the points of production of the meteorological perturbations can be obtained. [See also Abstracts 3121 and 3499 (1929).] R. C. F.

1183. Unbalance in Circuits. M. Reed. *Phil. Mag.* 8. *pp.* 341–353, *Sept.,* 1929.

When accurate measurements have to be made it is found that in addition to the normal impedances it is necessary to take into consideration the admittance to earth of various parts of the circuits under investigation. These admittances are generally very small, yet under certain conditions their effect on the measurement can be quite appreciable. This paper discusses how these admittances can influence the accuracy of a given measurement, and also how it is possible to avoid the errors they would cause. The chief divisions of the subjects dealt with are: (1) longitudinal voltages; (2) the balanced and screened transformer; (3) unbalances in practice; (4) the balanced circuit; (5) the unbalanced circuit. It is concluded that where possible it is desirable to use an unbalanced measuring circuit with one side earthed. With this type of circuit it is possible to eliminate most of the errors that arise from unbalances. Where it is essential to use a balanced measuring circuit it is necessary to employ shielded and well-balanced transformers in order to obtain consistent and accurate results. When connecting a balanced to an unbalanced circuit the circuits must be separated by a shielded transformer which is balanced on the side connected to the balanced circuit. J. J. S.

1184. Determination of Ballistic Demagnetisation Factor. D. Foster. *Phil. Mag.* 8. *pp.* 304–313, *Sept.,* 1929.

A method is described for experimentally determining the ballistic demagnetisation factor. By means of a double search coil of novel design the magnetisation and the magnetic field intensity are determined from ballistic galvanometer deflections. While the discussion refers mainly to circular cylinders, the scheme is adaptable to specimens of other shapes. It is particularly designed to obtain accurate measurements of field intensity in cylinders of small diameter. Details of a special design are given. Curves are given which illustrate the variation of the demagnetisation factor with the magnetisation, as well as the dependence of this relation on the material and on the dimensional ratio. AUTHOR.

1185. Magnetic Susceptibility of Cæsium. C. T. Lane. *Phil. Mag.* 8. *pp.* 354–362, *Sept.*, 1929.

The magnetic susceptibility of cæsium was measured in both the solid and the liquid state. The mean value of the specific susceptibility of a specimen in the solid state at 15° C. of density 1·90 was found to be $+ 0\cdot22 \times 10^{-6}$. Measurements of the susceptibility were made in 17 magnetic fields increasing from 4,780 to 24,200 gauss and remained without change. The mean value of the specific susceptibility of liquid cæsium at 28° C., density 1·84, was $+ 0\cdot20 \times 10^{-6}$, remaining constant in various magnetic fields from 10,100 to 24,200 gauss. J. J. S.

1186. Magnetic Susceptibility of Halogen Ions. K. Reicheneder. *Ann. d. Physik*, 3. 1. *pp.* 58–62, *Oct.* 2, 1929.

The magnetic susceptibilities of HCl, HBr and HI have been determined in aqueous solution. Assuming that the susceptibility of the H nucleus is zero, the atomic susceptibilities of the ions are $Cl^{-} = - 21\cdot9 . 10^{-6}$, $Br^{-} = - 32\cdot5 . 10^{-6}$, $I^{-} = - 50\cdot2 . 10^{-6}$, in good agreement with the values determined by Ikenmeyer by measurements on compounds of alkali metals with the halogens. If the water is at all affected by the H nuclei, this action is evidently very small. H. N. A.

1187. Barkhausen Effect in Iron, Nickel and Permalloy. Measurement of Discontinuous Change in Magnetisation. R. M. Bozorth. *Phys. Rev.* 34. *pp.* 772–784, *Sept.* 1, 1929.

These experiments show that the changes in magnetisation which take place suddenly in large groups of atoms account quantitatively for the whole change in magnetisation which corresponds to the steeper part of the hysteresis loop. Since it is estimated that discontinuities corresponding to groups of 10^{10} atoms (10^{-13} cm.^{3}), or less, will not appreciably affect the measuring system, it is concluded that the magnetic moments of only a very small number of atoms are reversed in groups smaller than this. The maximum size of the discontinuities for all the materials examined, independent of crystal size, is found to be about the same, corresponding to the complete reversals of the elementary magnets contained in a volume of about 10^{-6} cm.^{3} The discordance of the results of previous measurements by others is explained as due to the different rates of decay of the eddy-currents in the samples used. AUTHOR.

1188. Magnetic Properties of Isolated Ferromagnetic Atoms. F. W. Constant. *Phys. Rev.* 34. *pp.* 1217–1224, *Oct.* 15, 1929.

In order to obtain a better knowledge of the elementary atomic magnet, its behaviour when surrounded by non-magnetic atoms rather than by other magnetic ones has been studied. For this purpose alloys of 90 % and 95 % platinum, with the remainder cobalt and nickel, respectively, have been investigated. Only the cobalt alloys were found magnetic. The magnetic moment per cobalt atom being greater than for pure cobalt, the platinum may contribute to the magnetism. Variation of magnetisation with temperature and the Curie points have been measured, the latter falling rapidly as the cobalt content decreased. Various hysteresis loops, showing the relation between the magnetisation and applied magnetic force, have also been obtained, the hysteresis being less for the 10 % Co alloy, after annealing. In the hard-drawn state, however, the hysteresis and Curie points are considerably higher. The results are shown to be in agreement with Heisenberg's theory of ferromagnetism. AUTHOR.

1189. Effect of a Magnetic Field on the Interior Friction of Magnetic Solids. C. E. Guye and A. Dupraz. *Helv. Phys. Acta,* 2.5. *pp.* 320–342, 1929. *In French.*

The internal friction of soft iron, steel, nickel-steel, and nickel has been observed by measuring the logarithmic decrement of the torsional oscillations of a heavy disc, suspended from a wire of the material in question, in a vacuum, with and without a magnetic field. The oscillations were recorded photographically, and it was found that for small amplitudes the logarithmic decrements were independent of the magnetic field; with larger amplitudes the magnetic field produced a diminution of the logarithmic decrement, as already found by Bouasse and Carrière. This diminution is increased when the temperature is raised to 100° C. H. N. A.

1190. Magneto-Chemistry of Diamagnetic and Paramagnetic Metals and Alloys. H. J. Seemann. *Zeits. f. techn. Physik,* 10. 10. *pp.* 399–408, 1929.

A survey of magneto-chemistry summarising previous work. After outlining the theories of Pauli and Honda the author discusses the magnetic behaviour of alloys, referring specially to the Sb–Pb, Cu–Au, Tl–Pb and Cu–Zn series. In some instances, *e.g.*, Ag–Pb, certain alloys are paramagnetic, although both components are diamagnetic. In another section the relations between magnetic susceptibility and electrical conductivity are discussed, and it is shown that in certain instances alloys of greatest susceptibility have least conductivity, and vice versa. G. E. B.

1191. Thermoelastic Properties of Ferromagnetic Metals and the Molecular Magnetic Field. E. Bauer. *J. de Physique et le Radium,* 10. *pp.* 345–359, *Oct.*, 1929.

Most physical properties of ferromagnetic materials display anomalies in the neighbourhood of the Curie point. The author shows mathematically that the molecular magnetic field H_m admits of completing the equation of state of a ferromagnetic solid element, and that the dilatation and the elastic properties of these substances have an important bearing upon the magnetic properties. This applies particularly to dilatation and to nickel, much less well to iron; the predetermination by the aid of the magnetic curves of the thermomechanical properties can only be approximate. At ordinary temperature the ferromagnetic elements are under the influence of the field H in a state of spontaneous magnetisation and magnetostriction. As the temperature rises, the magnetism and magnetostriction diminish more and more, and the specific volume increases abnormally; at the Curie point the magnetostriction vanishes, the expansion coefficient drops suddenly, and the substance becomes normal. The author attempted to approach these problems by calculating the internal pressure of magnetic origin with spontaneous magnetisation, but found difficulties. He, therefore, proceeds by thermodynamics, calculating the available (not the total) energy and deducing from it the compressibility and dilatation energy. The experimental data are taken from Chévenard and from Weiss and Forrer, but the author limits himself to the elements, without discussing ferro-alloys. In the case of nickel the dilatation anomaly manifests itself already at 276° C. With iron the phenomena are very complex. There is no marked discontinuity at the Curie point, the diminution in dilatation sets in much below θ, and Swedish and electrolytic iron differ much. Other factors, such as Forrer's assumption of two magnetic modifications of iron, should be considered. In the last section Heisenberg's theory of ferromagnetism [see Abstract 2835 (1929)] and specific heats are referred to. This theory is again only approximate because, the author suggests, Heisenberg considers only loss of one electron and assumes a spherical symmetry of the electric field after this loss. H. B.

1192. Effective and Reversible Permeability. G. J. Sizoo. *Ann. d. Physik*, 3. 2. *pp.* 270–276, *Oct.* 8, 1929.

Reversible permeability has been dealt with by Gans [see Abstract 546 (1911)], who gave results for a number of magnetic materials. These results showed that the reversible permeability is a definite function of the magnetisation, though some results showed appreciable departures from this law and were attributed by Gans to non-homogeneity of the material. It is shown in the present paper that these apparent discrepancies disappear when the amplitude of the applied alternating magnetic field becomes infinitely small. For finite amplitudes the departure from the law increases at first rapidly and then more slowly. A. W.

1193. Magnetic Saturation of Ferrocobalt and the Atomic Moments of Iron and Cobalt. P. Weiss and R. Forrer. *Comptes Rendus*, 189. *pp.* 663–666, *Oct.* 28, 1929.

A series of 25 ferrocobalts was tested to saturation at ordinary temperature and down to that of liquid air. The results confirm, in the main, those of Preuss. Saturation has a maximum value for compositions between 35 % and 45 % of cobalt, and is then 12·4 % higher than for iron. As with ions of the iron family, the atoms of iron and cobalt can assume several different moments without change of lattice. These values are, in general, multiples of the experimental magneton. G. E. A.

1194. Fused Paramagnetic Salts. L. A. Welo. *Nature*, 124. *pp.* 575–576, *Oct.* 12, 1929.

A series of hydrated salts with low melting points was tested in the form of powders as to susceptibility for a range of temperature which included their melting points. The author's interpretation of the theory required a change of θ in the law: $\chi(T - \theta) = C$, diminished control in the liquid state requiring $\Delta\theta > 0$. For eight salts, θ changed in the anticipated direction, and fusion was accompanied by a change in the Curie constant. An exception was found in the case of erbium nitrate. The results, given in graph and table, are briefly discussed. G. E. A.

1195. Community of Origin and Quantitative Relations between the Actions of a Magnetic Field on Electric Currents and on Heat Flow. Parts A and B. A. Perrier. *Helv. Phys. Acta*, 2. 5. *pp.* 308–319, 1929. *In French.*

The author has already published a number of papers on the theory of metallic conduction, and has dealt in them with the effect of a magnetic field. The present paper gives a summary of these results, and discusses the Hall phenomenon, the Thomson effect, the Nernst and von Ettingshausen effect, the Leduc-Righi effect and the magnetic modifications of the Peltier effect. These are brought together under a single theory, and a series of investigations is suggested in which the exact relations between them should be obtainable. A number of interesting experimental confirmations of the theory have already been obtained. H. N. A.

1196. Quantistic Electrodynamics. E. Fermi. *Accad. Lincei, Atti*, 9. *pp.* 881–886, *May* 19, 1929.

The equations of electrodynamics are written in quantistic form even for the case in which there are electric corpuscles in the field. For the present only the form which corresponds to corpuscles of small velocity is given. J. J. S.

1197. Present State of Quantum Electrodynamics. P. Jordan. *Phys. Zeits.* 30. *pp.* 700–712, *Oct.* 15, 1929. *Paper read before the Theoret. Physikal. Conference, Charcow, May,* 1929.

Deals with the quantification of the characteristic vibrations in space and the existence of corpuscles, the direct quantification of the continuum, relativistic invariance of the quantification, the problem of several bodies, field quantification, and the results and problems of quantum electrodynamics. It becomes possible to understand the existence of light corpuscles as an effect of quantum mechanics, and the existence of electrons must be considered in an analagous way by means of a quantification of de Broglie waves. The paper shows how far it has been possible to build up a quantum theory of electrons and of their electrodynamical actions, what difficulties still exist and what are the prospects for further advance. The author is convinced that a solution of the difficulties in Dirac's theory can only be obtained in the frame of a complete quantum electrodynamics, and that it will be necessary in the future to avoid building up the theory in two separate steps and to proceed in one step, without the use of crutches formed of correspondences with a classical theory, in trying to formulate a pure quantum theory of electricity. H. N. A.

1198. Electromagnetic Effects. C. Bellia. *N. Cimento*, 6. *pp.* 261–274, *July*, 1929.

An experimental study was made of four electromagnetic effects, (1) transversal (Hall), (2) axial (la Rosa-Sellerio), (3) thermic transversal (Ettingshausen), (4) thermic axial, with a view to verifying the theory of Corbino and Volterra. Five sheets of bismuth varying in thickness, one of antimony, and one of iron were examined. The laminæ had an annular form. While in general the theory was confirmed, it was found that for thick sheets of bismuth the experimental results were not conformable to the theory, which indicates that the axial effect is a distinct phenomenon from the Hall effect. The electromagnetic thermic axial effect observed by Sellerio was not noticed in the three sheets experimentally examined. J. J. S.

1199. An Invariant Law of Variation Applicable to the Motion of a Number of Electrified Massive Particles. A. D. Fokker. *Zeits. f. Physik*, 58. 5–6. *pp.* 386–393, 1929.

A law of variation which is invariant under the Lorentz transformation is deduced. By the use of advanced and retarded potentials, the motion

of the particles is expressed in a perfectly symmetrical form. The laws of conservation of energy and impulse within the system are discussed.
J. S. G. T.

APPARATUS AND INSTRUMENTS.

1200. Voltage Regulator for Gas-Discharge X-Ray Tubes. F. E. Haworth. *J.O.S.A. and R.S.I.* 19. *pp.* 79–80, *Aug.*, 1929.

An ingenious device for automatically regulating the voltage across a gas X-ray tube. Inside the vacuum apparatus an aluminium float in a bath of mercury carries an armature and a bevelled-glass tube dipping into the mercury. After the initial adjustment the height of the float depends upon the pull on the armature, which is connected to the primary of the h.t. transformer. The connection between the vacuum pumps and the X-ray tube is through the glass tube carried by the float. The device works well with Hadding or Shearer tubes. W. H. Ge.

1201. Hot-Kathode X-Ray Tube for Use in Spectroscopy. C. J. Smith. *Journ. Sci. Instruments,* 6. *pp.* 251–253, *Aug.*, 1929.

Particulars are given of a demountable type of X-ray tube which can be readily constructed, since many of the essential parts are made of brass, and it can be cleaned easily or a new filament inserted. In the latter part of the paper an account is given of a device which forms a most satisfactory water cooler in cases where it is necessary to keep cool apparatus maintained at a high potential and which cannot be connected conveniently to the main water supply. R. S. R.

1202. Theory of Screened Impedances in A.C. Bridges. A. C. Bartlett. *Journ. Sci. Instruments,* 8. *pp.* 277–280, *Sept.*, 1929.

A theoretical discussion is given and an explanation brought forward of the action of shielded impedances in a.c. bridges with the Wagner earth. The paper is based on the work of Hartshorn and Wilmotte [see Abstract 785 (1927)]. J. J. S.

1203. Design of the Electron Collector for Retarding Voltage Analysis. H. W. B. Skinner and S. H. Piper. *Phil. Mag.* 8. *pp.* 313–319, *Sept.*, 1929.

In many experiments an electron collector (or Faraday cylinder) is used to measure the current in an electron beam, and a velocity analysis of the beam is carried out by applying a variable retarding voltage so as to stop the slower electrons. Various types of errors into which it is possible to fall in using an electron collector of the ordinary type are discussed, and a screened collector is described which for some purposes is a definite improvement on the usual type. J. J. S.

1204. Portable Electric Magnetometer. W. Uljanin. *Terr. Mag.* 34. *pp.* 199–208, *Sept.*, 1929. *In German.*

In determinations of the horizontal intensity of the earth's magnetism there is now a generally advancing tendency to replace the classical Gauss-Lamont method by the electric method on account of its recognised advantages, and the author gives in this paper a detailed description of his portable electric magnetometer. For determining the exact e.m.f. the "unsaturated" Weston-element was used. This is recommended on account of its vanishing temperature coefficient. J. J. S.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

1205. Radium Emanation Therapy. S. Meyer. *Akad. Wiss. Wien, Ber.* 138. 2*a*. 7. *pp.* 557–580, 1929.

The results of experiments on the radon content of expired air after the patient has either drunk water containing radium, inhaled radon containing air, or received baths in radium-containing water. It is shown that the emanation taken into the body is lost principally by way of expiration. In the case of patients having drunk radon water, the amount of radon remaining may be found from an expression $B_t = A_0 \frac{\lambda_1}{\lambda_1 - \lambda_2}[e^{-\lambda_2 t} - e^{-\lambda_1 t}]$, where λ_1 and λ_2 are characteristic constants, λ_1 an "expiration constant," and λ_2 a constant depending on the carrying of the radium from the stomach to the lungs. The half-value periods T_1 and T_2 are roughly 5–10 min. and 30–45 min. respectively. They vary for different patients (apparently being dependent on pulse frequency) and may be of diagnostic importance. For inhalation, three processes are concerned, λ_1 as before, λ_2 representing the emanation travelling from the lungs into the blood-stream and thence back into the lungs, the third constant being concerned with storage in the organism and having a value λ_3 corresponding to a half-value period of two hours. The equation representing expired radon and time is similar to those common in radioactive studies of three consecutive products. The effect of varying the time of inhalation of emanation is described. The patients having radioactive baths show practically the same phenomena as the inhalation subjects, suggesting that the emanation is chiefly breathed and not absorbed through the skin, though the evidence is not conclusive. W. V. M.

1206. Radiation from a Mercury-Vapour Lamp. W. R. G. Atkins and H. H. Poole. *Roy. Dublin Soc., Proc.* 19. *pp.* 355–364, *Sept.*, 1929.

Photochemical and photoelectric measurements were made with a Hewettic Levick Ulviare medical lamp. The uranyl oxalate method was used to study the rate of deterioration of a quartz mercury arc. The decrease in radiation appears to be non-selective, or nearly so, for the visible portion and near ultra-violet as compared with the middle and far ultra-violet stopped by 4·0 mm. of Pyrex glass. The Pyrex transmitted 40 %, clear Corex A (8·2 mm.) 70 %, and red-purple Corex A (10·2 mm.) 19 %. Radiation from a mercury arc produces erythema on the skin of the upper arm when it suffices to decompose roughly 0·056 mg. of crystalline oxalic acid per sq. cm. in 3 minutes, exposure of the uranyl oxalate solution being made in 10 c.c. portions in 13 × 1·6 cm. quartz tubes, internal diameter 1·3 cm., the tubes being placed with long axis parallel to long axis of lamp and at about 15° with a horizontal plane. Changes in a mercury arc may be followed with a glass vacuum sodium photoelectric cell of the Burt type. The 4 mm. Pyrex sheet transmitted enough radiation to produce a current 75 % of that with the unscreened cell; that passing the red-purple Corex A (10·2 mm.) gave 33 % with a new lamp and 30 % with one which had been in use for 360 hours. Double-surface flashed opal glass, 1·8 mm. thick, cut down the current to 46–47 % of the value for the unscreened cell. E. E. F. d'A.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

1207. Temperature Coefficient of Gas Adsorption at Maximum Saturation. F. J. Wilkins and A. F. H. Ward. *Zeits. f. phys. Chem.* 144. *Abt. A.* 3–4. *pp.* 259–268, *Oct.*, 1929.

The multi- and mono-molecular adsorption theories are stated and the alteration of the value for the maximum adsorption saturation in consequence of variation of temperature is deduced. The Langmuir theory and the Frenkel isotherm were utilised for the deduction of the above relationship, and at the same time the error in the Frenkel expression was defined and amended The Zeise theory for the effect of temperature upon molecular structure is shown to be unsatisfactory. The problem is further developed from the point of view that a sideways diffusion of the adsorbed gases can exist along the surface, and that at saturation a maximum value for the pressure of the adsorbed gases can be reached which is independent of the temperature. According to this theory the temperature coefficient of the adsorption maximum must be equal to the coefficient of expansion of a gas at constant pressure. It is shown by means of a table of numerical values obtained by experiment from a number of observers that this theory is confirmed. S. G. B.

1208. Measurement of Hydrogen-Ion Concentration in Unbuffered Solutions. Part I. Adsorbent Properties of Platinised Platinum. I. M. Kolthoff and T. Kameda. *Am. Chem. Soc., J.* 51. *pp.* 2888–2900, *Oct.*, 1929.

A platinised platinum electrode is immersed in the solution to be examined contained in a specially shaped cell, and hydrogen passed through for a suitable period; the solution is removed and its acidity, due to adsorption of base by the platinum, titrated. The cell is then filled with water and oxygen passed through, which removes the adsorbed base. In the cases of potassium chloride and sulphate, sodium and calcium chlorides and zinc sulphate (for which the method is slightly different), the amounts of acid and base are practically equivalent, showing that probably only adsorption has occurred. There is no sign of formation of monovalent zinc. From ammonium chloride solution practically no base was adsorbed, but oxygen passed through caused steadily increasing acidity. A similar result was obtained with trimethyl-ammonium chloride, and also (when oxygen was passed through for 25 hours) with potassium chloride. From sodium hydroxide with hydrogen strong adsorption occurs, showing a maximum for a 0·0007H solution and an increase on addition of sodium chloride; with oxygen the amount removed steadily increases with time. This, as also the results with ammonium chloride, etc., is attributed to the formation by oxidation of hexa-aquoplatinic acid, $H_2Pt(OH)_6$. Hydrochloric acid is not adsorbed from a solution thereof in presence of hydrogen, but is so in presence of oxygen. C. A. S.

1209. Diffusion and Passage of Gases in Liquids. Part I. Solution and Growth of Air Bubbles in Water. H. Mache. *Akad. Wiss. Wien, Ber.* 138. 2*a.* 7. *pp.* 529–556, 1929.

A method is described for the measurement of the diffusion coefficients in liquids which are not gas free and whose equilibria are altered by

adjusted pressures; its advantages over other methods are discussed. The variations of the gas bubbles with alterations in pressure are studied and a theoretical treatment included. The apparent dependence of the diffusion coefficient on the gas bubble radius is shown to indicate that the absorption coefficient of water for air in the concave surface layer of the bubble is lower than in the interior of the liquid. The effect of capillary pressure is investigated and experimental confirmation given to the theoretical result that the bubbles decrease by equal volumes in equal times. In moving water under constant excess pressure, the radius of the bubble diminishes in equal times by equal amounts, and the same holds good for the surface when only the capillary pressure is exerted.
H. H. Ho.

1210. Differential Equation Used in Physical Chemistry. H. Faxén. *Arkiv f. Mat. Astron. och. Fysik, Stockholm,* 21*B.* 3. [6 *pp.*] 1929. *In German.*

The development of the differential equation for diffusion and sedimentation is discussed. The paper does not permit of abstracting. F. J. B.

1211. Settling Velocity and Particle Size in Muds. A. H. M. Andreasen and J. J. V. Lundberg. *Kolloid Zeits.* 49. *pp.* 48–51, *Sept.*, 1929.

This paper continues previous work [see Abstract 373 (1930)] and investigates the relationship between particle size and settling velocity in a separator of the Schöne type. It is found that Stokes Law is approximately valid in the region investigated, but that with the greater velocities a weak tendency appears to be present towards a relatively strong increase for the corresponding size of particle in agreement with hydrodynamic theory. H. H. Ho.

1212. Accumulation of Gas in Closed Collodion Sacs Immersed in Flowing Tap Water. S. R. Guild. *Science,* 70. *pp.* 287–290, *Sept.* 20, 1929.

It is observed that gases in solution in slowly running water pass through the walls of collodion sacs filled with water or with aqueous solutions of various salts or gases and firmly closed without the inclusion of free gas bubbles, if these closed sacs are placed in the water containing the gases in solution. It is pointed out that this observation is important in connection with the study of living matter. The gaseous exchanges in respiration and the so-called secretions of gas in various forms are referred to in this connection. J. K.

1213. Dielectric Constant of Emulsions, Volumetric Concentration of the Dispersed Phase and Degree of Dispersion. A. Piekara. *J. de Physique et le Radium,* 10 *pp.* 360–369, *Oct.*, 1929. *Kolloid Zeits.* 49. *pp.* 97–102, *Oct.*, 1929.

The dielectric constant ϵ of an emulsion increases with the dispersion. The formulæ of Beer, Newton-Silberstein and Lorenz-Lorentz $f(\epsilon) = \delta_1 f(\epsilon_1) + \delta_2 f(\epsilon_2)$, where the δ represent the relative volumes of the two constituents of a mixture, do not consider the influence of grain size μ, and apply chiefly to homogeneous mixtures of two liquids. The formulæ do not hold generally, and Pulfrich's corrections of Lorenz-Lorentz are insufficient [see Grützmacher, Abstract 211 (1925)]. Wiener's formula for mixtures of solid bodies (cubes or spheres) with air was confirmed by John [see Abstract 982 (1918)]. The author examines mixtures of water-alcohol in oils, mercury in oils and mercury in two kinds of vaselin, in concentrations ranging from 0·0002 to 0·03, by the resonance method with two condensers and amplifiers. For constant ϵ_1, ϵ_2 and μ, δ is found to be more important than the Lorenz–Lorentz formula indicates; the values observed were twice as large as calculated. This is due to the volumetric concentration δ; the ϵ increases as the μ decreases. In oil emulsions the $\Delta\epsilon$ is not a linear function of the δ; the diminution of $\Delta\epsilon$ increases with increasing concentration because the directive forces of the dipoles enter. Vaselin is highly viscous, so that this disturbing influence does not become noticeable in it. H. B.

1214. Structural Changes in Colloidal Gel Films Produced by Stretching. J. Trillat. *J. de Physique et le Radium*, 10. *pp.* 370–384, *Oct.*, 1929.

The specimens of block shape, formed by piling films upon one another until the thickness and width of the block are both 1·5 mm. are examined by X-rays (K_α of copper) at 40,000 volts while stretched, the direction of the rays being parallel or at right angles to the direction of the stress. The stretching makes the originally isotropic gel anistropic, but as the film was already stretched when pulled off, the extension-ratios (2·6 : 1 maximum) are really too small. The effects are studied in three planes at right angles to one another. The anistropy produced shows in the appearance of haloes in the equatorial line, but only in two directions; this indicates a linear development of the molecules, which tend to orient themselves in the direction of their longitudinal axes and deviate less from this orientation as the stress is increased. On further stretching, the rings turn into ellipses, with strong equatorial and weak polar haloes when the X-rays are perpendicular to the stress direction. Finally, a pseudo-crystalline structure is observed, but the amorphous character does not vanish completely, and the alignment of the molecules is not perfect. The observations are in accord with the author's views on the superficial structure of liquids [see Abstract 2359 (1929)], the gels resembling in their statistical molecular arrangements liquids which have turned highly viscous. This structure and the elongated shape of the molecules explain also the increased mechanical strength, as in the hardening of metals by cold work. The materials studied, nitrocellulose and acetylcellulose, behaved somewhat like rubber, without showing the reversibility of the phenomena observed in rubber. H. B.

1215. Mechanism of Amalgamation. C. E. Guye and I. Archinard. *Helv. Phys. Acta*, 2. 5. *pp.* 343–356, 1929. *In French. Arch. des Sciences*, 11. *pp.* 312–345, *Nov.–Dec.*, 1929.

Thin wires of gold and silver were hung with their lower ends in mercury. The velocity of amalgamation along the wire was observed. Also small drops of mercury were placed in the centre of horizontal plates and the rate of spreading noted. The results agree approximately with an exponential law derived on certain assumptions. A. A. D.

1216. Order of Removal of Metals from Amalgams. A. S. Russell. *Chem. Soc., J. pp.* 2398–2401, *Oct.*, 1929.

The order of removal of molybdenum, tungsten and bismuth from mercury by oxidising agents has been redetermined with respect to other metals whose positions are known from earlier work. The complete order of those metals investigated is Zn, Cd, Mn, Tl. Sn, Pb, Bi, Cu, Cr, Fe, Mo, Co, Hg, Ni and W. Molybdenum and cobalt lie close together in this order, and so do mercury and nickel. AUTHOR.

1217. Limit of Solubility of Copper in Reversible Iron-Nickel Alloys. P. Chevenard. *Comptes Rendus*, 189. *pp.* 576–578, *Oct.* 14, 1929.

Copper is miscible with nickel in all proportions in the solid state, but has only slight solubility in iron, and forms solid solutions of limited range in reversible ferro-nickels containing sufficient iron. The boundary of the two-phase field in the γ-iron-nickel-copper constitutional diagram is determined with greater precision by dilatometric means than by thermal analysis or microscopic examination. The supersaturated solution obtained by quenching breaks down on annealing, with a contraction in volume. The temperature-dilatation curve shows an imperfectly reversible transformation on passing from the two-phase to the one-phase field, and *vice versa*. The contraction-time curve at constant temperature is logarithmic, and the rate of the reaction increases exponentially with temperature. A. J. M.

1218. Thermal Decomposition of Fatty Primary Alcohols. K. Kashima. *Chem. Soc. Japan, Bull.* 4. *pp.* 177–190, *Aug.*, 1929.

Reference is made to the work of Berthelot on the thermal decomposition of ethyl alcohol, to that of Sendrens on the influence of catalysts and to the studies of Ipatiew on the decompositions of *n*-propyl alcohol. In this paper the results are recorded of the decomposition products obtained under various experimental conditions for methyl, ethyl, *n*-propyl and *n*-amyl alcohols. J. K.

1219. Reduced Equations Used in Chemical Kinetics. W. Świetoslawski and J. G. Zawidzki. *Acad. Polonaise Sci. et Lettres, Bull.* 6A. *pp.* 295–315, *June*, 1929. *In English.*

The work of J. Zawidzki, Sr., on reduced equations which he introduced into chemical kinetics is discussed. It is shown that at a later period he changed his views as to the advantage of using equations with reduced time, and employed the transformed time axis. This method is developed by the present authors and applies as time unit the time during which one-, two- or three-quarters of the reaction substratum have undergone change. Directions for determining the form of the kinetic equation with use of the reduced form, corresponding to the chemical reaction, are given. F. J. B.

1220. Equilibrium $CO_2 + C \leftrightarrows 2CO$. F. J. Dent and J. W. Cobb. *Chem. Soc., J. pp.* 1903–1912, *Sept.*, 1929.

Schenck and Heller demonstrated in 1905 that the composition of the mixture of carbon monoxide and dioxide in equilibrium (in the blast furnace) with carbon varied with the modification of the carbon used. This is still disregarded, though the equilibrium equations of various workers do not agree, and though the heats of reaction of the different modifications vary with the modification. These heat values in cal. per *g*.-atom of carbon burnt in oxygen are, according to Roth and Nikitin, natural graphite, 41,810; coke, 40,490; charcoal, 39,480; and methane carbon (deposited at 800°), 38,300. The apparatus of the authors resembles that used by Rhead and Wheeler for continuously circulating CO_2 and the CO formed by its reduction over coke kept at

800° in an electric furnace. The temperature must remain very constant, and the gases must be rapidly cooled after passing over the carbon, especially when the reaction is slow in the absence of catalysts. For the rapid cooling they place the material—preheated to 900° or higher to expel all gas—in the bulbular furnace portion of a silica tube which is almost closed in the constricted ends, next to the bulb, by the insertion of silica rods. When the coke to be tested is impregnated with sodium carbonate in order to increase the rate of the reaction, the silica tube is replaced by a tube of porous Morgan material of uniform width, the ends being packed with blocks of the Morgan material. In the case of Ceylon graphite the equilibrium CO percentage was found to rise from 7 to 13·8 in 255 hours; the latter figure would correspond to Roth and Nikitin and seems to be the value belonging to saturated graphite carbon. In the case of coke and charcoal, impregnated or not, the values did not differ much. The lower figures would be due to carbon containing unsaturated atoms on the surface. When the carbon is heated, the unsaturated atoms appear to pass gradually into the more stable saturated state. This transformation is not favoured by impregnation with soda, and the graphitisation is slower than the industrial gasification of the carbon. H. B.

1221. Equilibrium Constants of Reactions Involving Hydroxyl. D. S. Villars. *Nat. Acad. Sci., Proc.* 15. *pp.* 705–709, *Sept.*, 1929.

The equilibrium constants of the following reactions for temperatures from 1000° abs. to 2505° abs. are calculated from entropy considerations, using a value for the heat of dissociation of OH obtained by interpolation of band spectra data: $2OH = H_2 + O_2$, $2H_2O = 2H_2 + O_2$, $2H_2O = H_2 + 2OH$, $2OH = H_2O_2$. The results are compared with the constants obtained by using the smaller value for the heat of dissociation of OH given by Bonhoeffer. A. J. M.

1222. Equilibrium of Polyatomic Gases in the New Statistics. H. Ludloff. *Zeits. f. Physik*, 57. 3–4. *pp.* 227–241, 1929.

Based on the new statistics, and on analogy with a recent investigation of Gibson and Heitler [see Abstract 2609 (1928)], a mathematical study has been made of the dissociation equilibrium of polyatomic molecules containing three or four like atoms. The value of the equilibrium constant is found to depend [see Abstract 2810 (1927)] on whether the molecules possess a mirror-image isomer or not. H. H. Ho.

1223. Photochemical Oxidation with Potassium Dichromate. D. S. Morton. *J. Phys. Chem.* 33. *pp.* 1135–1141, *Aug.*, 1929.

The oxidation of ethyl alcohol by potassium dichromate under the action of light was studied. The results showed that under suitable conditions dichromate solutions were photochemically active for light which was absorbed by the dichromate. The oxidising power of the dichromate solution increased with increase of acidity, and the apparent action of light consequently decreased. The light reaction was complete or zero for mixtures of ethyl alcohol, potassium dichromate, with varying amounts of acid. It was pointed out that Luther and Forbes rendered the chromic acid photochemically inactive when they studied the photochemical oxidation of quinine by chromic acid in 5·4 *N* sulphuric acid. The conclusions of Luther and Forbes were shown to be untrue in the general sense. F. J. B.

1224. Primary Process of Light Absorption and Activation in Photochemical Reactions. K. P. Basu. *J. Phys. Chem.* 33. *pp.* 1200–1203, *Aug.*, 1929.

Employs Raman's discovery that part of a quantum of incident radiation can be absorbed by a molecule and the remainder scattered as a quantum of modified frequency, to explain the fact that in photochemical reactions a single quantum generally activates more than one molecule of the absorbing substance. This has usually been explained by a chain mechanism, but the author suggests that the scattered quantum may activate another molecule, and that this action may continue until the scattered quantum has so small an energy that the process ceases. Explains the increase of photochemical efficiency with increase in the frequency of the incident radiation. H. N. A.

1225. Detection of Dissociation of Halogen Molecules Effected by the Direct Action of Radiation. H. Senftleben and E. Germer. *Ann. d. Physik,* 2. 7. *pp.* 847–864, *Sept.* 4, 1929.

By employing the thermal conductivity of a gas as a criterion for dissociation, it is possible to demonstrate the dissociation of chlorine, bromine and iodine as the results of the action of radiation. In order to cause such dissociation, the wave-lengths of the rays must be less than the convergence positions of the band edges, this being in agreement with Franck's theory of the dissociation of polyatomic molecules. The longest wave-lengths with which dissociation is detectable lie, for all three halogens, in the immediate neighbourhood of the limits of the edge series determined optically. T. H. P.

1226. Photochemical Decomposition of Chlorine Monoxide and Chlor-Sensitised Ozone Decomposition. H. J. Schumacher and C. Wagner. *Zeits. f. phys. Chem.* 5. *Abt. B.* 3–4. *pp.* 199–208, *Sept.*, 1929.

It is suggested that for both these reactions the formation of the intermediate compound ClO helps the reactions to proceed [see Abstract 3684 (1929)]. The authors also discuss why the yields by photochemical decomposition in carbon tetrachloride solutions are only half that for reactions taking place in the gaseous phase. For the heat of formation of ClO a lower limiting value is given. It is also stated that ClO is probably formed as an intermediate product in the photochemical decomposition of mixtures of chlorine and chlorine monoxide. J. K.

1227. Photochemical Decomposition of Iron Pentacarbonyl. G. Eyber. *Zeits. f. phys. Chem.* 144. *Abt. A.* 1–2. *pp.* 1–21, *Oct.*, 1929.

The yields per light quantum on the photochemical decomposition of iron carbonyl are determined. The influence of foreign gaseous additions is also studied, and, finally, the vapour pressures of iron pentacarbonyl are determined between − 14° to + 20° C. It is shown that there is a yield of two molecules per light quantum at a wave-length of 400 mμ, and that the speed of reaction for a given pressure is directly proportional to the concentration. The addition of foreign gases restrains the reaction velocity. The addition of oxygen, however, leads to a different type of decomposition. J. K.

1228. Hysteresis Phenomena in Physico-Chemical Systems. N. v. Raschevsky. *Zeits. f. Physik,* 58. 7–8. *pp.* 523–539, 1929.

Systems with several equilibrium states have been investigated which, according to a previous investigation [see Abstract 2008 (1929)], should exhibit hysteresis phenomena. The following special case is considered: In an equilibrium condition the system changes by an external influence E_1 but not by another E_2, yet when E_2 precedes E_1 the system assumes another equilibrium state in which it also is only influenced by changes of E. Reference is made to some possible relationships of this kind of hysteresis phenomena with the so-called limited reflexes. H. H. Ho.

1229. Growth of Silver Iodide Films. U. R. Evans and L. C. Bannister. *Roy. Soc., Proc.* 125. *pp.* 370–394, *Sept.* 2, 1929.

The iodine was brought into contact with the silver foil by dipping the latter in a solution of iodine in chloroform. The relation between the thickness of the silver iodide film formed and its interference colour was determined, the assumption that the thickness of the film can be obtained by dividing the equivalent air thickness by the refractive index being shown to be inexact. Nephelometric and electrochemical methods for determining film thickness were compared with the microgravimetric method. These do not involve exposure of the silver to air before depositing, but experiments showed that pre-exposure to air at ordinary temperatures hardly affected the subsequent formation of iodide films. The relation of film thickness (y) to time (t) was studied under different conditions of solvent, stirring rate, abrasive treatment, temperature and concentration. The general conclusion as to the mechanism of the film formation is that the iodine passes through pores of a few molecular diameters, in loose union with the silver iodide—a process intermediate in character between diffusion in solid solution and gaseous leakage through definite cracks. W. S. S.

1230. Gaseous Combination in Electric Discharges. Part IV. Effect of Moisture upon Kathodic Combustion of Carbonic Oxide Detonating Gas. G. I. Finch and D. L. Hodge. *Roy. Soc., Proc.* 125. *pp.* 532–542, *Oct.* 1, 1929.

"Detonating gas" is a mixture of carbonic oxide and oxygen in their combining proportions [see Abstract 3429 (1929)]. Over a certain range of pressure, gap width and current an electric discharge can be passed through moist detonating gas to produce purely kathodic combustion, the rate of which is directly proportional to the current. Moisture accelerates combustion at non-sputtering electrodes (Ta and W), but retards combustion at freely sputtering electrodes (Pt, Ag, Au and Pd). The data lead to the conclusion that the combustion of moist detonating gas is determined by a prior ionisation of the molecules. At freely sputtering electrodes steam molecules within the kathode zone condense on sputtered metal atoms, forming clusters, which promote combustion by neutralising the electrostatic repulsive forces between positively charged ions. Combustion at non-sputtering kathodes is proportional to the number of separate moisture clusters within the kathode zone, and is effected by the electrostatic forces of repulsion between the positively charged ions being overcome by the negatively charged moisture.

A. J. M.

1231. Explosions with Para-Hydrogen. F. Goldmann. *Zeits. f. phys. Chem.* 5. *Abt. B.* 5. *pp.* 305–306, *Oct.*, 1929.

The behaviour of ortho- and para-hydrogen on explosion was investigated and the explosion limits were determined. It was shown that the passage of the explosion flame transformed the excess of para-hydrogen into ordinary hydrogen, and the velocity of explosion was that of ordinary hydrogen. The behaviour is a characteristic example of the increase of reaction velocity in the zone of the explosion by the collision of primary particles rich in energy. F. J. B

1232. Diffusion Phenomena in the Lower Explosion Limits of Hydrogen-Oxygen Gas. F. Goldmann. *Zeits. f. phys. Chem.* 5. *Abt. B.* 5. *pp.* 307–315, *Oct.*, 1929.

The well-known phenomenon of the difference between the lower explosion limit of hydrogen and the upper limit of inflammable vapour, which depended upon whether the gas was ignited at the top or bottom of the gas column, is explained as the result of diffusion. The diffusion is rendered visible by the heating of the particles of platinum or palladium which were introduced into the gaseous mixture from the platinum wire, or palladium foil electrode. F. J. B.

1233. Ignition of Crossing Streams of Oxygen and Inflammable Gases. F. Goldmann. *Zeits. f. phys. Chem.* 5. *Abt. B.* 5. *pp.* 316–326, *Oct.*, 1929.

The ignition of two streams of oxygen and an inflammable gas which met at right angles was studied. The oxygen and the inflammable gas are heated to differed temperatures and then allowed to meet. The conditions under which ignition occurs are observed, and from the results an ignition curve is constructed. F. J. B.

1234. Movements of Flame in Carbonic Oxide-Oxygen Explosions. H. B. Dixon. *Nature*, 124. *pp.* 580–584, *Oct.* 12, 1929.

A short review of the phenomena of flame propagation in dry and in moist gases, followed by an exposition and appreciation of the work of Bone and Fraser. [See Abstract 3430 (1929).] J. H. A.

1235. Formation of Gaseous Hydride of Gold. A. Farkas. *Zeits. f. phys. Chem.* 5. *Abt. B.* 6. *pp.* 467–475, *Oct.*, 1929.

When gold was heated to 1400° C. in a stream of hydrogen a very large amount was volatilised. The high volatility was shown to be due to the formation of gold hydride AuH. The dissociation heat was calculated from the increase of volatility by Nernst's theorem, and was found to be 71750 ± 3750 cal., which equals 3·10 ± 0·16 volts. The dissociation heat of silver hydride was obtained from similar volatility determinations, and was found to be 57500 ± 6300 cal. or 2·49 ± 0·27 volts. F. J. B.

1236. Effects of Magnetic Field on Chemical Reactions. S. S. Bhatnagar, R. N. Mathur and R. N. Kapur. *Phil. Mag.* 8. *pp.* 457–473, *Oct.*, 1929.

From the theoretical discussion it is concluded that a chemical transformation from a diamagnetic to a paramagnetic or a less diamagnetic state should be accelerated, and that from a feebly diamagnetic to a more strongly diamagnetic state should be retarded. A critical study of previous work shows that in almost all cases where negative results were obtained, the following causes may be ascribed: (1) too great reaction velocity; (2) insufficiently sensitive analytical methods; (3) no appreciable difference between the susceptibilities of the initial and final reaction products. Six types of reaction have now been studied under conditions which avoid the above difficulties, and it is found that the velocity of reaction is increased in those homogeneous reactions in which the sum of the molecular susceptibilities of the reactants becomes greater as the reaction proceeds. H. H. Ho.

1237. Photolytes of Solutions of Hydrogen Sulphide in Hexane and Water, and Photolysis of Solutions in General. E. Warburg and W. Rump. *Zeits. f. Physik*, 58. 5–6. *pp*. 291–305, 1929.

In contrast to the previously investigated hydrogen iodide solutions [see Abstract 1410 (1928)] the electrolytic dissociation of photolytes may be neglected. Hydrogen sulphide solutions in hexane obey the equivalent law, whilst in water they do not, a difference ascribed to the fact that H_2S does not react with hexane but does so with water. A brief discussion is given of the photolysis of solutions in general. H. H. Ho.

1238. Calculation of Heat of Dilution of Salts. J. B. Goebel. *Zeits. f. phys. Chem.* 143. *Abt. A*. 2. *pp*. 167–171, *Sept.*, 1929.

An empirical formula is developed from some results of recent measurements for the calculation of the heat of dilution U of salt solutions. The equation is designed for use at great and practically infinite dilutions. The investigation is extended to the calculation of the heat of dissociation Q, by the use of the van't Hoff equation $\log k_1/k_2 = Q/R(1/T_2 - 1/T_1)$. F. J. B.

1239. Thermal Data Revisions. Part I. W. A. Roth. *Zeits. f. phys. Chem.* 144. *Abt. A*. 3–4. *pp*. 253–258, *Oct.*, 1929.

The importance of exact thermochemical measurements is first emphasised and the necessity for revising much of the inorganic thermal data pointed out. The assumptions underlying exact methods are discussed, and it is shown that the periodic system provides a criterion for the reliability of thermal data. In collaboration with D. Müller the heats of formation of silicon dioxide (204·0 ± 2·1 k. cal.) and of aluminium oxide (380·8 ± 0·4 k. cal.) have been redetermined in the bomb calorimeter at constant pressure. Both values are higher than those previously accepted. H. H. Ho.

1240. Metallic Concentration Cells Violating Volta's Second Law. O. Scarpa. *Accad. Lincei, Atti*, 9. *pp*. 1007–1014, *June* 1, 1929.

The cells studied were of the type $Pt \mid A_1 \mid A_2 \mid Pt$ where A_1, A_2 are amalgams either of zinc or of cadmium of two different concentrations. They are sharply distinguished from the usual concentration cells in which an electrolyte, such as zinc sulphate, is interposed between the two amalgams. In the cells studied, the e.m.f. is only of the order of 1 microvolt. The energy is derived from the diffusion of the dissolved metal from one amalgam to the other, and they thus contradict the "law of tensions" in that a current may flow in a purely metallic circuit which is at constant temperature throughout. The phase diagram of the zinc-mercury system shows that there are no inter-metallic compounds, at least above − 50° C. The results are considered in the light of the theory that metals contain positive ions capable of migration. J. H. A.

1241. Overpotential of Bismuth in Acid Solutions. W. V. Lloyd. *Faraday Soc., Trans.* 25. *pp*. 525–529, *Sept.*, 1929.

Results are given which show that the incidence of maximum commutator overpotential of bismuth in acid solutions indicates a constant degree of supersaturation of the electrode with hydrogen, which is independent both of the hydrogen-ion concentration of the electrolyte and also of the anion of the solution. This result is in agreement with the conclusions of Glasstone, but not with those of Herasymenko for polarisation at very small current density with no evolution of hydrogen gas. The commutator experiments made show further that the overpotential of bismuth in acid solutions is approximately 0·1 volt greater than that of antimony in acid solutions, as found by Sand, Grant and Lloyd [see Abstract 2187 (1927)]. This result disagrees with those of Newbury, who found that the overpotentials of the two elements differ by 0·01 volt. T. H. P.

1242. Contact Potential between Similar Metal Surfaces. W. Ende. *Phys. Zeits.* 30. *pp.* 477–480, *Aug.* 1, 1929.

An experimental method is described for measurement of contact potential difference between pieces of the same material for brass, nickel and platinum in air and also *in vacuo* (with and without cooling by liquid air). Various types of surface were used, produced in a variety of ways to determine whether any difference of contact potential occurred with type of surface. It was found that contact potentials (0·05 volt) were produced by surfaces obtained by sawing, turning, filing and treating the metal surface with a sand blast. Contact potentials up to 0·5 volt were produced by washing and corrosion, and particularly by rubbing with emery paper. The latter surfaces were, therefore, considered less favourable as producing higher voltage. S. G. B.

1243. Photovoltaic Cells with Silver/Silver Bromide Electrodes. Part II. S. E. Sheppard, W. Vanselow and V. C. Hall. *Kodak Research Lab., Comm. No.* 362. *J. Phys. Chem.* 34. *pp.* 1403–1414, *Sept.*, 1929.

The work begun in Part I [see Abstract 2325 (1929)] is continued. A system comprising an amplifier-oscillograph was used to obtain photographic records of the photo-potential changes in the first second of the illumination. Photovoltaic cells consisting of silver/silver bromide electrodes in various electrolytes were studied by this apparatus. The factors affecting the potential studied were: age of electrode, Svensson-Becquerel effect, halogen acceptors, electrolytes and intermittent exposure to light. The results supported the view proposed in the first paper, that the initial negativisation was due to the simultaneous release of electrons, some of which escaped combination with silver ions, but reached the silver electrode, thus increasing the electron pressure in the metal. F. J. B.

1244. Potentials of Solutions of Carbohydrates. Nelicia Mayer. *Comptes Rendus*, 189. *pp.* 319–321, *Aug.* 12, 1929.

Wurmser and Geloso have shown [*Journ. Chimie physique*, 25. 641, 1928] that a difference of potential is established between an inert electrode and a solution of a reducing hexose which, all other things being equal, has the same value whether the hexose be glucose or fructose. The present investigation extends the above work to lactose, galactose, mannose, xylose, arabinose and dioxyacetone. The experimental cell, whose e.m.f. was measured was Pt | solution of hexose | KCl saturated | KCl, HgCl, Hg. The result found was that the contact potential at the platinum was established at variable rates, but that its ultimate value proved to be the same for all the cases studied. In the presence of borates the potential undergoes displacement in a positive sense. As in the case of glucose and fructose, the potentials determined with the other hexoses were not modified by the addition of small quantities of an oxidation-reduction system, such as that of phenosafranine, in rapid equilibrium with the electrode. In the case of xylose the potential does not vary sensibly when the concentration is altered from 0·1 % to 2·5 %. It appears, therefore, that the difference of potential towards an inert electrode is independent of the nature of the hexose. H. H. Ho.

1245. Preliminary Determinations of Standard Electrode Potentials in Methyl Alcohol. P. S. Buckley and H. Hartley. *Phil. Mag.* 8. *pp.* 320–341, *Sept.*, 1929.

Various sources of error have occurred in determinations of the standard electrode potentials of certain elements in methyl alcohol and the results of different investigators do not show satisfactory agreement. The authors undertook a new series of determinations of these constants for certain uni- and divalent elements, the measurements being planned so as to avoid as far as possible previous sources of error. A study of reference electrodes, of liquid-junction potentials, and of activity-coefficients in methyl alcohol is described. Measurements were made of the standard electrode potentials of nine elements, Na, Tl, Cd, H, Cu, Ag, I, Br, Cl, and the results used for determining the solubilities of five sparingly soluble salts and the dissociation constant of methyl alcohol. The quinhydrone electrode was studied in aqueous and alcoholic solutions. A steady value was not obtained for the potential of this electrode in methyl alcohol. J. J. S.

1246. Investigations with Quinhydrone Electrodes. A. E. Brodsky and F. I. Trachtenberg. *Zeits. f. phys. Chem.* 143. 3–4. *pp.* 287–300, *Sept.*, 1929.

A general theory of the quinhydrone electrode is developed and the literature of the subject discussed. Measurements are then described for concentration cells of saturated quinhydrone electrodes with respect to the hydroquinone electrodes at different concentrations of the latter in seven solvents. The data calculated from solubility measurements are in agreement with those obtained from direct analytical methods. The osmotic pressure theory of galvanic cells is found to be unsuitable for application to non-aqueous solutions. H. H. Ho.

1247. Change of Electrocapillary Curve of Mercury with Temperature. O. Koenig and E. Lange. *Zeits. f. Elektrochem.* 35. *pp.* 686–695, *Sept.*, 1929. *Paper read before the Deut. Bunsen Gesell., Berlin, May*, 1929.

The paper forms a contribution to the question of the absolute value of the electrochemical potential of mercury. The theory of the measurement of the absolute potential by means of the electrocapillary curves is discussed, and the dependence of the curve on temperature is determined from published data. The paper does not lend itself to a brief summary, and must be consulted for details. F. J. B.

1248. Influence of Temperature upon Photovoltaic Electromotive Forces. G. Athanasiu. *Comptes Rendus*, 189. *pp.* 460–462, *Sept.* 23, 1929.

Previous work by Rigollot and by Iimori and Takebe [see Abstract 3338 (1928)] have shown that the photovoltaic electromotive force in certain cases increases as the temperature diminishes, and in the present paper this temperature variation is studied for a large number of sensitive electrodes under identical experimental conditions, *viz.*, Ag–AgI, Ag–AgBr, Hg–Hg_2I_2, Cu–Cupric oxide and Ag–Ag_2S. Full experimental details are given with data, and in every case examined the photovoltaic e.m.f. is found to increase as the temperature diminishes. This is explained on the assumption that the direct photochemical reaction and the inverse reaction which tends to re-form the substance decomposed by the light are unequally influenced by temperature, the latter much more so than the former. H. H. Ho.

1249. Differential Potentiometric Titration of Weak Acids in Dilute Solutions. B. L. Clarke and L. A. Wooten. *J. Phys. Chem.* 33. *pp.* 1468–1480, *Oct.*, 1929.

An apparatus and method for the differential potentiometric titration of weak acids in concentrations as low as 0·0004 *N* are described. The theory of the differential method is presented, and methods are deduced from it for estimating the endpoint. AUTHORS.

1250. Relationships between Potentials of Halogen Ions and Their Ultra-Violet Absorption in Aqueous Solution. G. Scheibe. *Zeits. f. Elektrochem.* 35. *pp.* 701–703, *Sept.*, 1929. *Paper read before the Deut. Bunsen Gesell., Berlin, May,* 1929.

The ultra-violet absorption spectra of aqueous solutions of alkali bromides and iodides show that all the alkali and alkaline earth bromides on the one hand and all iodides on the other show the same absorption at dilutions below normality. This can only be explained by the fact that this absorption arises from the halogen ions environed by water molecules and that no appreciable influence is due to the kation. The primary process in the absorption of light by dissolved halogen ions is regarded as a disintegration into dissolved atom and electron. Similarly, during electrolysis of alkali halogen solutions the primary process at the positive electrode is a decomposition of the ion into atom and electron. It is probable that the energy changes in the optical and electrolytical processes are the same, and the present paper contains a preliminary discussion of this relationship. Previous work on the iodine and bromine ions is referred to [see Abstract 449 (1929).] H. H. Ho.

1251. Difficulties in Hittorf's Theory of Electrolytic Conduction. S. Ray. *Zeits. f. Elektrochem.* 35. *pp.* 469–470, *Aug.*, 1929.

The only experimental fact in proof of Arrhenius's already dissociated molecules is the weak current which passes under the smallest e.m.f., below the critical e.m.f. required for dissociation of the molecule. The required brief current is provided by the drive of a charged salt-molecule in the electric field. Hittorf's theory does not provide for the inequality in the ion-velocities. But it is not necessary to assume that the ion-velocities are the same throughout the course; if we assume them, as measured, to be initial velocities only, the sole condition for their reaching equal average values is the constancy of the ratio ϵ/a. A. D.

1252. Conductance of Electrolytes. Part II. Improvements in the Oscillator and Detector. G. Jones and G. M. Bollinger. *Am. Chem. Soc. J.* 51. *pp.* 2407–2416, *Aug.*, 1929.

In the first of this series of papers a description was given of a new form of alternating-current bridge [see Abstract 2816 (1928)]. In the present paper a few improvements in the accessories of the bridge are described. When measuring the conductance of solutions it is desirable to use a low voltage in the bridge, and an account is given of a modification of the oscillator to give low and controllable voltages. Such voltages diminish the sensitiveness, and to remedy this the amplifier is improved. The principles of design of the transformer for a vacuum-tube amplifier are discussed and means of increasing the sensitiveness described. The use of a wave filter in parallel with the telephone is recommended. The mutual inductance between the oscillator and detector and between oscillator and bridge may cause an error in the measurement of the conductance of solutions when low voltages are used and means for the discovery and elimination of this error are explained. J. J. S.

1253. High-Frequency Conductivity and Dielectric Constants of Aqueous Solutions of Electrolytes. H. Rieckhoff. *Ann. d. Physik*, 2. 5. *pp*. 577–616, *Aug*. 15, 1929.

A method of determining the change of conductivity of electrolytes in a high-frequency field is developed. The method is a substitution method using KCl as a comparison electrolyte. The wave-length employed was 1 metre. Results were obtained for twenty electrolytes containing groups of different valencies, at different concentrations, and are in fair agreement with the theory of the dispersion effect of Debye and Falkenhagen; in some cases the agreement is very close. The deviations were usually for solutions containing ions of high valencies. The effect of temperature was also investigated, and the results were, on the whole, in harmony with the theory. The measurements of the dielectric constants confirmed the results of Hellman and Zahn, and the measurements were extended to some electrolytes which had not been examined. F. J. B.

1254. Conductivity Measurements in Highly Dilute Alcoholic Solutions. L. Thomas and E. Marum. *Zeits. f. phys. Chem*. 143. 3–4. *pp*. 191–215, *Sept*., 1929.

Results are given of measurements of the conductivity of the sodium and piperidinium salts of hydrochloric acid, picric acid, and trinitro-m-cresol in aqueous solutions, the following limiting conductivities (λ_∞) being determined by extrapolation: sodium chloride, 127·5; sodium picrate, 81·3; sodium trinitro-m-cresylate, 80·3; piperidinium chloride, 113·5; piperidinium picrate, 67·3; piperidinium trinitro-m-cresylate, 66·3. In methyl (ethyl) alcohol, the values of λ_∞ are: sodium chloride, 100·5 (43·0); sodium bromide, 104·8 (44·9); sodium iodide, 110·3 (47·8); sodium picrate, 94·7 (45·8); sodium trinitro-m-cresylate, 92·7 (44·0); piperidinium chloride, 112·6 (50·4); piperidinium picrate, 106·8 (53·2); piperidinium trinitro-m-cresylate, 104·8 (51·4). From measurements of the conductivity of solutions of hydrogen chloride in absolute and aqueous methyl and ethyl alcohols, the partition constants of the equilibrium alcohol-hydrogen ion-water are calculated to be 0·25 and 0·06 respectively, and the differences in mobility of the alcoholated and hydrated hydrogen ion 97·5 and 40·3 respectively. The fact that the viscosity law is obeyed appears to confirm the existence of complex ions such as water-$H^\cdot$ and alcohol-$H^\cdot$. T. H. P.

1255. Dispersion of Electrolytic Conductivity. B. Brendel, O. Mittelstaedt and H. Sack. *Phys. Zeits*. 30. *pp*. 576–578, *Sept*. 30, 1929.

Establish the variation of the electrolytic conductivity of $MgSO_4$

solution with the frequency in the case of waves of lengths 10 to 30 m. The maximum variation is about 1·6 %. E. E. F. d'A.

1256. Conductance and Transference Number of Chloride Ion in Mixtures of Sodium and Potassium Chlorides. D. A. MacInnes, I. A. Cowperthwaite and T. Shedlovsky. *Am. Chem. Soc., J.* 51. *pp.* 2671–2676, *Sept.*, 1929.

An addition to the moving boundary apparatus for determining transference numbers is described, with the aid of which the boundary can be formed without disturbing the apparatus while it is mounted on a vibration-free support. Transference numbers of the chloride-ion constituent in tenth-normal mixtures of sodium and potassium chlorides have been determined. Accurate conductance measurements have been made on the same solutions. Within the experimental error chloride-ion conductance is the same in the mixtures as in the solutions of the pure salts. There is no evidence of complex ion formation. AUTHORS.

1257. Transference of Water and its Dependence on Concentration in Electrolysis of Sodium Chloride Solutions. Millicent Taylor and E. W. Sawyer. *Chem. Soc., J. pp.* 2095–2106, *Sept.*, 1929.

No migration of urea is observed in a 0·1*N* solution at 25° C. under a p.d. of 210 volts in 21 hours. Using urea as the non-electrolytic reference substance in two complete migration experiments with a 0·5*N* sodium chloride solution, the transport of water to the kathode detected by Washburn in a *N* solution is confirmed. Transport numbers for sodium and chlorine ions in the 0·5*N* solution are obtained which are concordant among themselves and consistent with values interpolated from the most trustworthy data for other concentrations. The weight of water transported per Faraday in the 0·5*N* solution is found to be greater than that given by Washburn for the *N* solution. The number of water molecules attached to each ion is calculated, assuming it to be independent of concentration at constant temperature. The values obtained are greater than any previously suggested for solutions of finite dilution. A. J. M.

1258. Activity Coefficients, and Transference Numbers of Cadmium Chloride and Bromide. W. W. Lucasse. *Am. Chem. Soc., J.* 51. *pp.* 2597–2608, *Sept.*, 1929.

Values are given of the e.m.f. at 25° C. of the cell $\mathrm{Hg,Cd}|\mathrm{CdX_2}|\mathrm{AgX}|\mathrm{Ag}$, the concentrations of the cadmium chloride and bromide, represented by $\mathrm{CdX_2}$, varying from 0·01 to 6M and from 0·01M to 3M respectively. These data are used to calculate the values of the activity coefficients of the salts over the same ranges of concentration. The results are given of measurements at 25° C. of the e.m.f. of cadmium chloride and bromide concentration cells with liquid junctions at the same concentration ranges, the kation transference numbers being then calculated. T. H. P.

1259. Conductivity and Electronic Structures of Organic Acids in Solution. H. Hunt and H. T. Briscoe. *J. Phys. Chem.* 33. *pp.* 1495–1513, *Oct.*, 1929.

The conductances of various organic acids in methyl, ethyl, propyl, and butyl alcohol and acetone have been measured at 30° C. The conductances of substituted benzoic acids, and a few unsaturated and dibasic acids have been measured in ethyl alcohol. The results have been interpreted in terms of the electron theory of valence and current theories of molecular structure. [See also Abstract 2642 (1929).] AUTHORS.

1260. Acidity and Ionic Potentials. J. N. Brönsted. *Zeits. f. phys. Chem.* 143. *Abt. A.* 3–4. *pp.* 301–312, *Sept.*, 1929.

Ionic potentials, *e.g.* the hydrogen ion potential, which may be regarded as the measure of the acidity of a solution, and the electrical potentials in chemical systems, are not defined quantities on the basis of the ordinary thermodynamic methods. It is now shown, however, that by using the conception of the electro-neutrality of these functions, a procedure may be established which enables their measurement. H. H. Ho.

1261. Anodic Behaviour of Aluminium. A. Güntherschulze. *Zeits. f. phys. Chem.* 143. Abt. A. 1. *pp.* 62–68, *Aug.*, 1929.

With reference to the work of Müller and Konopicky [see Abstract 3441 (1929)] it is pointed out that these authors did not pay sufficient attention to the cleansing of the aluminium surfaces before their experiments, to the complication of the phenomena by the solubility of the aluminium, and to the great influence of temperature on the solubility. The new theory advanced by these authors is regarded as untenable. T. H. P.

1262. Formation and Properties of Very Thin Electrolytic Nickel Deposits. K. M. Oesterle. *Zeits. f. Elektrochem.* 35. *pp.* 505–519, *Aug.*, 1929.

The electrodeposition of nickel is affected by the simultaneous evolution of hydrogen and the formation of the hydrate $Ni(OH)_2$ which is not at first visible and increases with the *p*H concentration of the electrolyte. By systematically changing this concentration from *p*H 1 to 6, the author obtains a series of deposits, differing in appearance, structure, and magnetic and mechanical properties. With a current density at the kathode of 25 milliamperes the nickel is deposited on platinum kathodes in a thickness of the order of 2×10^{-4} cm. from $NiCl_2$ with additions of acetate, ammonium chloride, boric acid, and gelatin. The spontaneous contraction of the deposit is determined according to Kohlschütter and Jakober [see Abstract 3235 (1927)] and the magnetic susceptibility by a pendulum magnetometer; the strength is tested by smoothing and bending the specimen, and the degree of dispersion of the particles by X-Ray examination according to Debye and Scherrer. When the *p*H is low, no hydrogen is evolved, and the deposit is bright grey-white; the grain becomes finer as the *p*H increases up to 4·5, while a colloidal turbidity (hydrate) appears in the liquid. Above 4·5 the turbidity disappears, but the deposit turns greenish with hydrate; above 6 only hydrate is deposited. Below 4·5 small additions of gelatin turn the fine-grain deposit into a violet or brownish mirror which always contains some hydrate; at higher *p*H the deposit becomes scaly again, and a gelatin froth appears at the anode. The small amount of gelatin appears to act as protective colloid for the hydrate, not as dispersing medium. The first particles of the nickel deposit are oriented in cohering crystallites, which is particularly noticeable with hot acid baths; afterwards the $Ni(OH)_2$ inhibits the development and orientation of single crystals. The thinnest films observed (10^{-5} cm.) were not non-magnetic like the films of Ingersoll and de Vinney [see Abstract 2609 (1925)]. H. B.

1263. Electrolytic Dissociation of Metal Malonates. H. L. Riley and Nellie I. Fisher. *Chem. Soc., J. pp.* 2006–2010, *Sept.*, 1929.

The degree of dissociation of magnesium, cadmium, zinc and copper malonates and magnesium oxalate was calculated from conductivity

measurements. The measurements were made by the Kohlrausch method over a range of concentration from 1 mol in 12·5 litres to 1 mol in 1655·4 litres. The bearing of the results on the theory of electrolytes is discussed.
F. J. B.

1264. Electrochemical Behaviour of Gold and Platinum in Hydrochloric Acid Solution. G. Grube.

Zeits. f. Elektrochem. 35. *pp.* 703–709; *Disc.*, 709–710, *Sept.*, 1929. *Paper read before the Deut. Bunsen Gesell., Berlin, May*, 1929.

In the electrolytic refining of gold, which is carried out in a hot hydrochloric acid solution of $HAuCl_4$, the equilibrium $3\ \mathrm{Au} \rightleftarrows 2\ \mathrm{Au} + \mathrm{A\ddot{u}}$ plays an important rôle, and the present investigation studies this equilibrium by a series of experiments in which finely divided gold is shaken with neutral and hydrochloric acid solutions of $HAuCl_4$ at different temperatures for long periods of time in the thermostat. Tables of data are given. After establishing the equilibrium, the e.m.f. of the cell. Au (or Pt)|$HAuCl_4$, $HAuCl_2$ solution|3·5*N*KCl|N.KCl, HgCl|Hg, was measured, and the results discussed. Supplementary work has also been carried out on the anodic behaviour of platinum towards strong hydrochloric acid and the result obtained that platinum may be very easily and almost quantitatively dissolved in the tetravalent condition. Further work with platinum is in progress. In the discussion the author states it as probable that the anodic tetravalent dissolution of platinum proceeds more easily than the divalent dissolution.
H. H. Ho.

1265. Electrolysis with Diaphragms. O. Essin.

Zeits. f. Elektrochem. 35. *pp.* 492–500, *Aug.*, 1929.

A relation found between the concentration of the salt used and that of the alkali formed. This relation enables us to deduce from Foerster and Jorre's theoretical law the empirical law of Guye and also a relation between the concentration of the salt and the yield of alkali. Guye's empirical law is an approximation; the exact form can be obtained, but is inconvenient for calculation. The equations agree well with the experimental results.
A. D.

1266. Cataphoretic Migration Velocities of Zeolitic Suspensions. A. Buzágh.

Kolloid Zeits. 49. *pp.* 35–39, *Sept.*, 1929.

The author tabulates and plots his results in connection with the migration velocities of electrodialysed chabasit and electrodialysed synthetic aluminium silicate dispersions in presence of various electrolytes. The alkali hydroxides in small concentrations increase and in larger concentrations diminish the electrokinetic potential. With Ca- and Ba- hydroxides only a decreasing action is noted for all concentrations. The effects of the chlorides of mono- and di-valent kations as well as of aluminium and thorium are also recorded. It is concluded that electrodialysed geolitic suspensions with reference to electrokinetic phenomena behave in a similar manner to the suspensions having an electro-negative charge in water.
J. K.